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Modernizing the Distilled-Water Ice Plant
Robert G. Skerrett

Bettering the Water Supply of a Seaside Resort
S. G. Roberts

The Castleton Bridge of the New York Central Railroad
Sidney Mornington

Silencing Air Compressor Intakes
Hiram Percy Maxim

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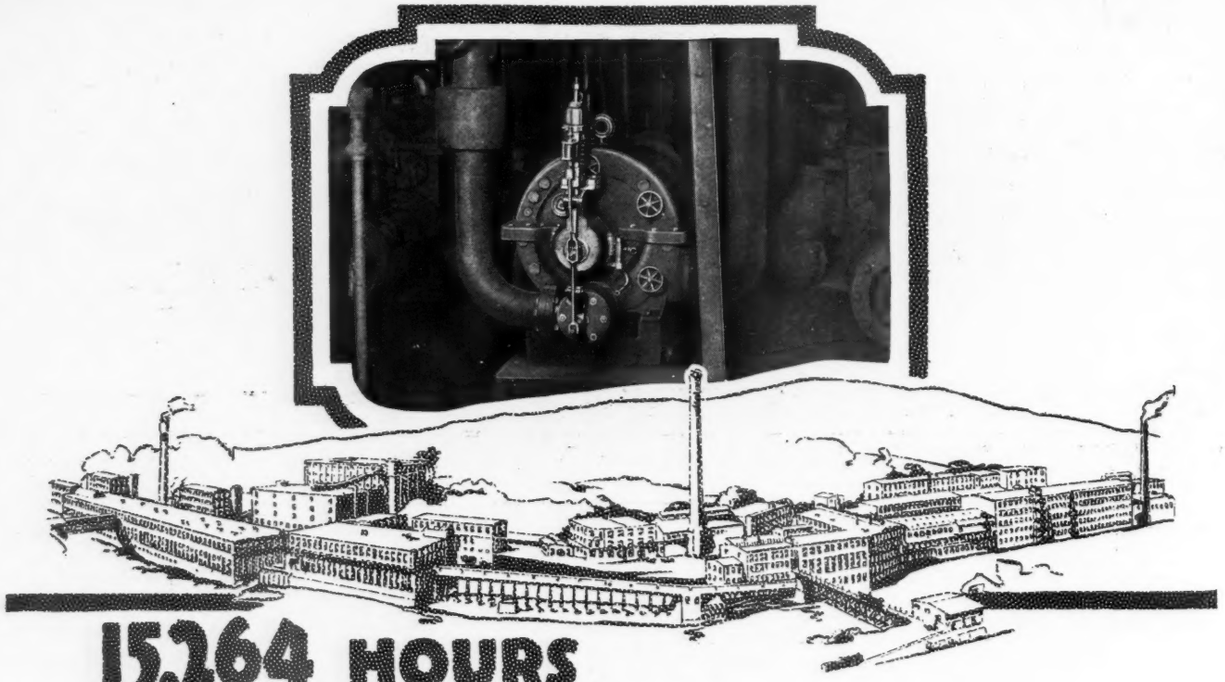

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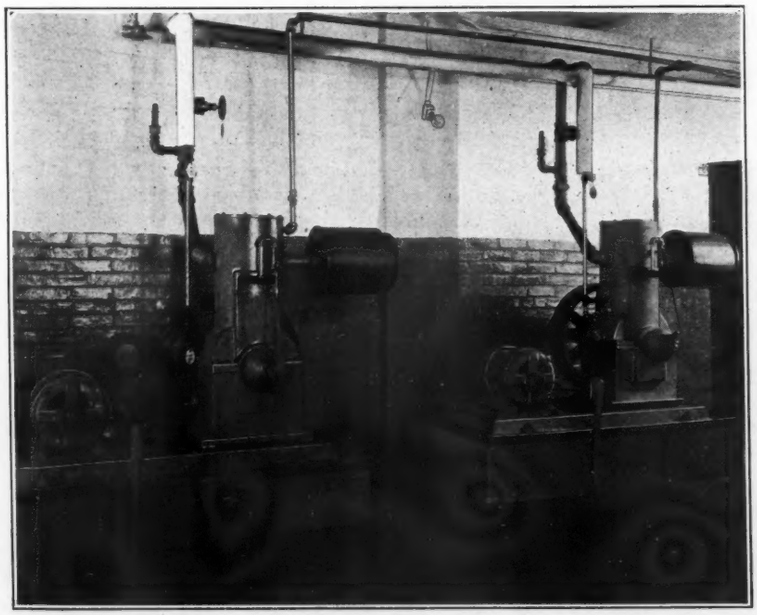

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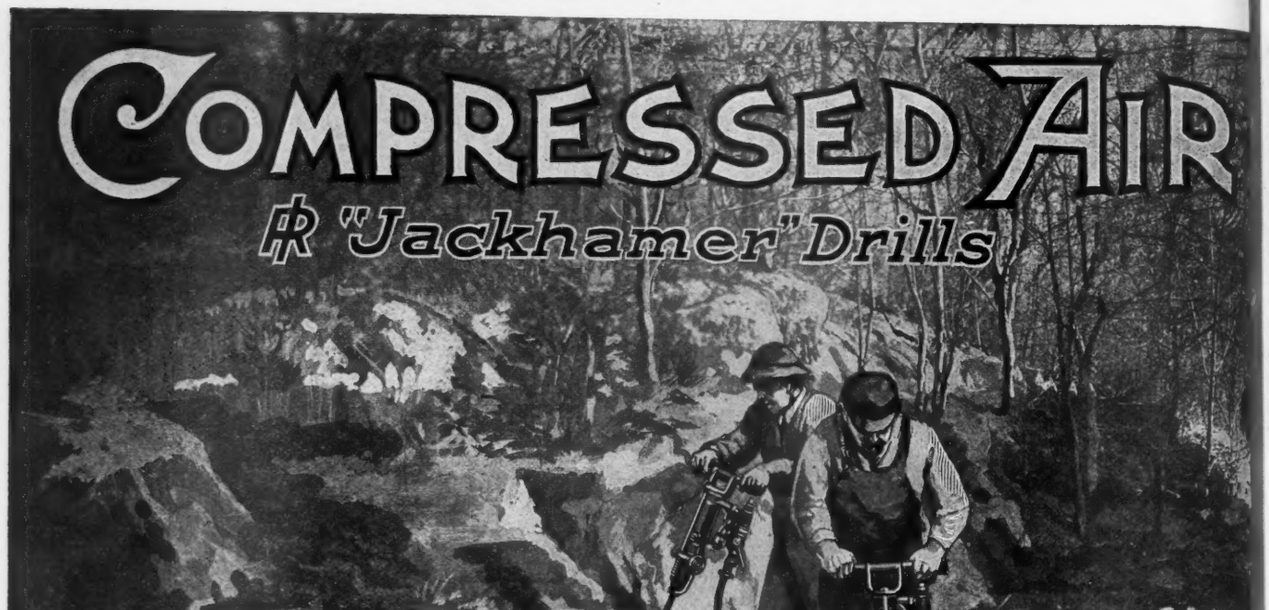

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FEBRUARY, 1923

Bettering the Water Supply of a Seaside Resort

What Has Been Done to Improve the Air-Lift System Installed at Allenhurst, New Jersey

By S. G. ROBERTS

PURE water, and plenty of it, is demanded nowadays in every up-to-date community. In the average town or city the quantitative aspect of this problem is of gradual growth and reasonably constant throughout any given year. This is not the case, however, at seasonal resorts where people flock for a few months annually in quest of pleasure and physical recuperation.

At such places not only is the number of transients widely variable, but there are apt to be among the summer visitors a good many invalids and children who are especially susceptible to or incapable of resisting the action of any lurking impurities in the water.

The accompanying article describes how a seaside resort on the coast of New Jersey has met its water problem and has taken steps to provide for its present and future requirements by recourse to an installation of a highly flexible and economical nature.

THE BOROUGH of Allenhurst, N. J., has a winter population of about 350 persons, but in the summertime the town accommodates substantially 3,800 people. On the face of it this fluctuation imposes conditions that are radically different from those prevailing in what might be termed a stabilized community. Again, the population is largest just when everyone wants to use a maximum measure of water. Not only that, but creature comfort and the aesthetic sense make additional demands for water to sprinkle the streets and to spray the lawns and the flower beds, which add considerably to the freshness and the charm of the place. Finally, as a safeguard against the hazard of fire, it is imperative that there shall be an abundance of water for fighting flames.

Like most of the neighboring seaside towns, dependence for several decades has been placed upon fairly deeply sunken wells which have been driven down to what is known as the 550-foot water stratum—a water-bearing sand which closely resembles quicksand. This latter point should be kept in mind, because it will be realized presently that water from such a source introduces mechanical difficulties. The earlier of the Allenhurst wells was sunk approximately 28 years ago, and for eight years thereafter suction pumps were employed to raise the water. Along about 1902, the suction pumps, proving uneconomical and in some other ways objectionable, were condemned and air lifts were installed in their stead. At that time, that system of raising water from so-called Artesian wells was something of a novelty, and the art, relatively speaking, was then in its infancy.

For the information of those unfamiliar with the operative principles of the air lift, a brief description of its essential features might not be out of place here. It is a striking example of how elemental forces can be brought into play to do man's bidding by causing one column of water to lift above its level another column of water from the same source. At first blush, this seems a contradiction of all that we have been taught in our schoolday study of physics; but here is where the jugglery of the inventive engineer has apparently upset the law of gravitation.

Picture a pipe within a pipe—the larger forming the casing of a well and the smaller and axial one serving as a discharge line which projects through a cap sealing the upper end of the enveloping casing. The discharge pipe extends far enough down inside the bigger pipe to have its lower end considerably below the level of the water in the well. Now, visualize a third and still smaller pipe descending through the cap of the casing and connecting with the central discharge main near the bottom of the latter so that it can deliver into the water pipe a stream of compressed air. In a rough way, we have now sketched the prime parts of an air lift, and, next, let us see how the apparatus works.

The compressed air, on entering the lower section of the discharge pipe, diffuses itself in a mass of bubbles throughout the column of water in that tube and, in effect, thus reduces the weight or the specific gravity of that volume of water compared with that of the outlying column of water held within the well casing. As a result, the heavier outlying column tends to force upward the lighter column composed of an admixture of air and water. In this way, the water in the well can be brought not only to the ground surface but to a considerable height above that level. Nothing could be simpler; and this system of pumping possesses a number of advantages which will be explained a little later.

At various times, as Allenhurst grew and the need of more water developed, the town authorities sank additional wells to tap the 550-foot stratum, and today there are five of these wells in service. Two of them have casings 4½ inches in internal diameter, while the three remaining have each a diameter of eight inches. The discharge pipes reach down into the wells to depths ranging from 140 to 160 feet. Until last year, the air for all five of these wells was supplied by an 11 and 11x12-inch "XB-1" compressor having a maximum rating of 55 pounds air pressure. For eighteen months or more that machine was called upon to operate at about 20 per cent. overload in order to supply enough air to furnish the added volume of water required by the popular resort. It might be mentioned here that when the compressor was purchased, a working pressure of 35 pounds at the receiver was ample to take care of the water needs of Allenhurst.

Inasmuch as Allenhurst and all of the neighboring towns for miles around draw upon the

same water stratum, and the drain has increased steadily in recent years, the water level in the wells has dropped, and the working air pressures have had to be raised to compensate for the difference in lift and for the resistance offered by the installation of more piping. Until last summer, the piping leading from the several wells to a common reinforced-concrete reservoir was run underground. These lines ranged in length from 25 feet to 1,000 feet, and the longest of them followed devious courses containing several bends, drops, and elevations between the tops of the wells and the reservoir. In other words, the compressed air had not only to lift the water from the wells but to force it along through the more or less crooked, buried conduits. This, in itself, necessitated higher air pressures; and matters were made still worse when sand and corrosion clogged the mains or hindered the flow of the water.

Indeed, the situation came to such a pass in Allenhurst that it was manifestly plain that something would have to be done to effect a betterment and to guard against a local shortage which might compel the authorities to buy water from a near-by community. As the chief engineer of the Borough Waterworks picturesquely expressed it: "We used to throw dice and pray for rain. We were continually worried at the peak-load period." Before describing the steps taken which greatly improved conditions, it would probably help to a clearer understanding of the whole problem if we gave a general outline of the town's dual water supply system.

For fire fighting and for sprinkling purposes, the water is obtained from a small lake within the town limits; and this water is handled by two Cameron centrifugal pumps which deliver

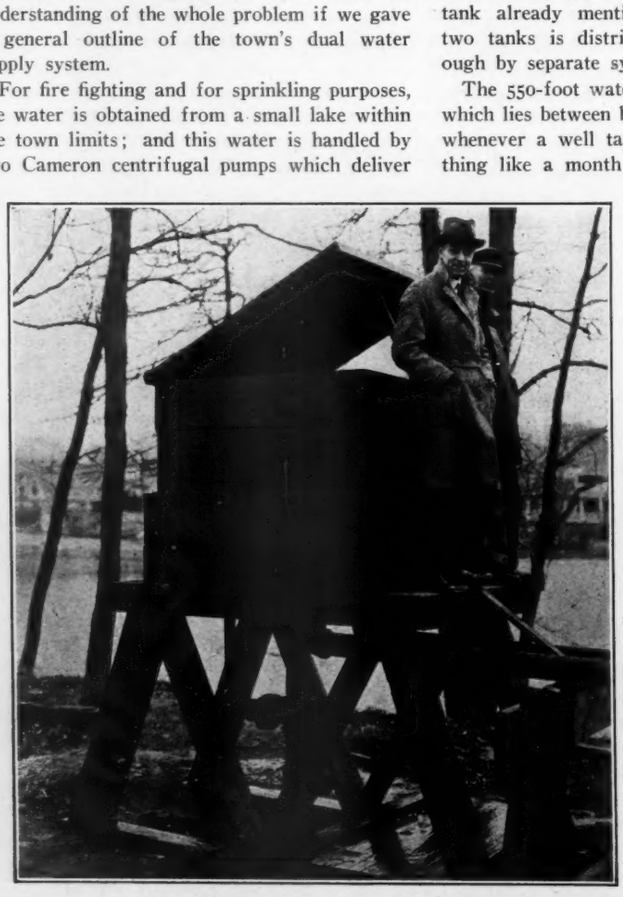
The pump-house of the Borough Water Works, Allenhurst, N. J.

it to a tank of 50,000 gallons capacity elevated 90 feet above the ground. This arrangement insures a head ample enough to throw water over the top of any building in Allenhurst. Similarly, two more electrically driven centrifugal pumps raise the drinking water from the underground concrete reservoir, in the yard adjacent to the pump-house, and discharge it into another 50,000-gallon tank alongside the tank already mentioned. Water from these two tanks is distributed throughout the borough by separate systems of piping.

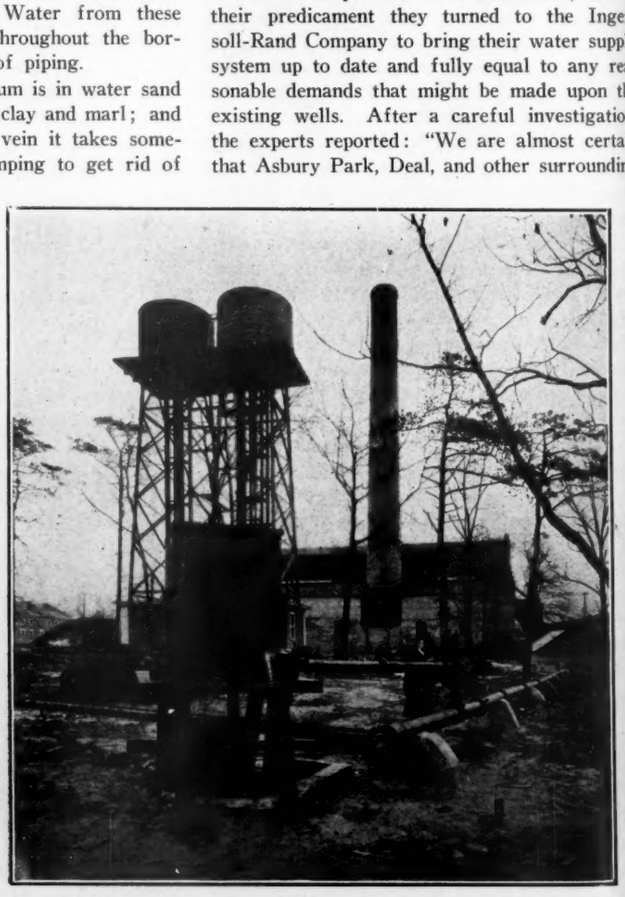
The 550-foot water stratum is in water sand which lies between beds of clay and marl; and whenever a well taps this vein it takes something like a month of pumping to get rid of most of the free sand and to obtain comparatively clear water from the pocket surrounding the bottom of the casing. Even so, an appreciable amount of sand is always brought to the surface by the pumps; and in the case of the air lifts at Allenhurst this sand used to pass onward and into the reservoir, where it was kept more or less in suspension by the continual movement of the water. As a result, this sand was drawn from the reservoir into the centrifugal pumps, where its cutting action caused damage and lowered operating efficiency.

Prior to the middle of last year, the five air lifts had to be kept going for an hour or 45 minutes to furnish enough water to fill the 6,735-gallon reservoir; and at the height of the season the compressor had to be operated well-nigh continually. Expressed in another way, if the centrifugal pumps took fifteen minutes to draw a given quantity of water from the reservoir the air lifts took three times as long to replace that volume. And, what is equally illuminating, the Borough Waterworks had no reserve machine to carry on in case the hard-pressed compressor failed. Indeed, the compressor was not idle long enough at any time to permit overhauling its valves, putting in new gaskets, or doing other things needful to maintain it in proper condition.

The foregoing summary of the situation at Allenhurst eight months ago very naturally disturbed the responsible local authorities, and in their predicament they turned to the Ingersoll-Rand Company to bring their water supply system up to date and fully equal to any reasonable demands that might be made upon the existing wells. After a careful investigation the experts reported: "We are almost certain that Asbury Park, Deal, and other surrounding



The air lift and the surge-box of the Havens Well which is one of the best of the Artesian wells at Allenhurst.



The two tanks which supply water directly to the two systems at Allenhurst. One tank carries drinking water and the other one contains water for fighting fire and for sprinkling lawns, etc.

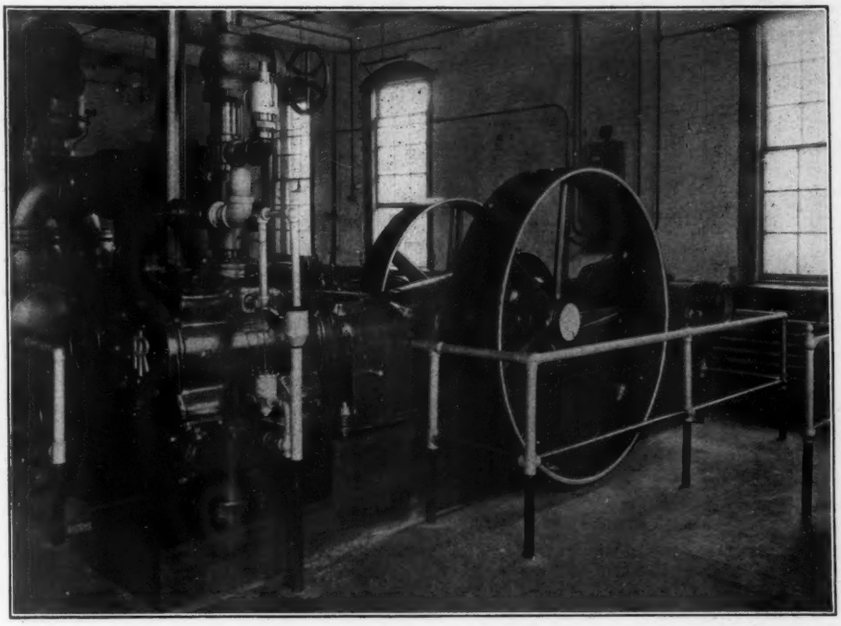
cities, which pump from the same water stratum as Allenhurst, are using high air pressures. With higher pressures deeper submergence of the discharge pipes would be practicable, and this would mean that the water could be pumped with much less air. Further, if more water should be available in the wells, then, of course, more would be pumped. It is evident that each year a greater quantity of water is being withdrawn from the 550-foot stratum, and, accordingly, the static head in this section of the country is falling gradually.

"Therefore, in order to pump as much water as is now being raised, it will be necessary to take the utmost advantage of the submergences possible with the present wells, or to drill additional wells. In either case, we recommend the installing of another machine having a rated capacity of 100 pounds pressure, which would permit recourse to the best submergence and render it feasible to obtain the desired measure of water more economically than can be done with one compressor of the present capacity—the latter to serve as a reserve unit."

Profiting by the foregoing report, the administrative officials of Allenhurst authorized the engineering concern in question to go ahead and to make such changes in the existing installation as would insure the much desired results. An electrically driven 14x12-inch compressor, type "ER-1," was set up in the pump-house to supplement the older "XB" compressor, which had had to bear the entire operative burden previously. Since no data was available regarding the size and the lengths of the discharge pipes in any of the wells save one, it was deemed advisable to withdraw the discharge pipe from one of the wells and to repipe it. When this was done at what is known as the Kisner Well, the former piping was discovered to be too large for the quantity of water the well was producing. That is to say, the discharge pipe was 4½ inches in diameter, and the operating air was supplied it by a 1-inch line.

The Kisner Well was repiped with 62 feet of 3-inch, 70 feet five inches of 3½-inch, and 32 feet of 4-inch piping—the latter being the uppermost section of the discharge line. At the bottom or intake end of the new piping was secured a No. 4 "VA" Ingersoll-Rand pump or foot-piece. Prior to these alterations, the Kisner Well required a working pressure of about 46 pounds and a consumption of 117 cubic feet of air per minute to deliver 124.2 gallons of water every 60 seconds. After refitting with a taper discharge pipe, etc., the well yielded 126.8 gallons of water in the same interval at a working pressure of 42 pounds and with an air consumption of 56.3 cubic feet per minute. On the face of it, a saving of 52.5 per cent. was effected in the quantity of air used.

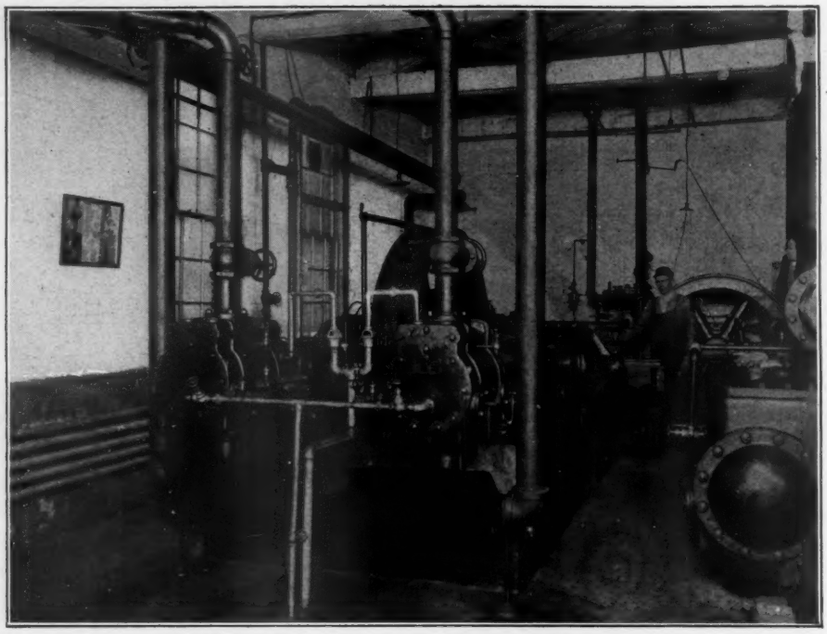
To obviate certain of the objectionable features which had characterized the underground connections, which had up to the first half of last year extended from the discharge pipes of the wells to the concrete reservoir in the pump-house yard, the two wells furthest removed from the reservoir were arranged to discharge directly into surge-boxes placed several feet above ground—the outlets being fitted with umbrella deflectors. The employment of surge-boxes and deflectors serves not only to eliminate the backing up of the air pressure in the horizontal lines, which formerly occurred and added to the load on the compressor, but this innovation aerates the water to a greater extent than was previously possible with the old system. In short, the new procedure is a big asset in purifying the water for domestic use.



The "ER-1" 14x12-inch compressor, which is driven by a 79-H. P. electric motor. This is the latest addition to the air-lift equipment.

From the surge-boxes at the Kisner and the Havens wells, the water flows by gravity to a concrete settling-basin—a new feature—where a removable board bulkhead or baffle causes the precipitation of the sand and allows the water to pass on over its top and, by way of a 10-inch main, to travel easily onward by gravity to the reservoir. The settling-basin has virtually stopped the movement of all sand from the copious Kisner and Havens wells to the reservoir, and to that extent has greatly reduced the troublesome grit to which the centrifugal pumps used to be exposed. It is worth while mentioning here that the Havens Well, when inspected recently, was discharging water from its umbrella deflector in a steady stream at the rate of approximately 300 gallons a minute. In other words, more water was issuing from the 4½-inch discharge

Three centrifugal electric-driven, direct connected Cameron pumps are installed in the plant of the Borough Water Works.



The "XB-2," 11 and 11x12-inch compressor, which is driven by a 79-H. P., electric motor.

pipe than two 4-inch mains could carry off from the enveloping surge-box. An automatic start and stop feature has been installed whereby the compressor in the pump-house can be controlled by a float which is actuated by the water level in the outlying and near-by reservoir.

The compressed air is not fed directly from the compressor to the several wells but is first delivered to a receiver of 48-inch diameter and 120 inches in length. Normally, the gage of the receiver indicates a pressure of from 85 to 90 pounds, but this is momentarily raised to 107 pounds just before the wells break or begin to give water on starting up. Afterwards, when the wells are flowing freely, the air pressure drops to from 85 to 90 pounds. Interposed between the elevated tanks and the centrifugal pumps, which draw water from the reservoir and force it up to the overhead distributing tank, is the filtration plant, which is made up of two units. These are of a type turned out by the New York Continental Jewell Filtration Company; and one of the filters is purged daily by blowing or flushing.

The same air that is used to raise the water can also be employed effectually in cleaning out any sediment which may accumulate within the air lift. This can be done by what is known as "back-blowing," which consists in shutting in the lift by closing the valve at the top of the discharge pipe while still admitting compressed air to the lift. This builds up a back pressure in the discharge pipe and reverses the movement of the water and air through the foot-piece. This procedure serves admirably to keep clear the passages in strainers, etc., and is a distinctive virtue which can be claimed for the air-lift system.

The utmost care is exercised by the Borough authorities to make sure that the water is uniformly pure. Each month three bottles of it are sent to Trenton for analysis by the state chemist. One of them is filled with so-called raw water just as it comes from the wells; one is filled with water after it has been filtered; and the third bottle contains water drawn from a residential faucet. Should anything be found wrong it is thus possible to locate the source of the taint.

What has been done by Allenhurst is suggestively valuable to those many other communities along the Jersey Coast which are similarly obliged to get their water from wells that tap the same 550-foot water stratum and which are also subjected to very marked seasonal variations in the number of people that have to be taken care of. From an engineering point of view the results obtained at Allenhurst are of widespread value, because it is a matter of general knowledge, among those engaged in equipping wells of that sort, how much trouble and expense may be incurred either in preparing the wells so that floating sand may be held at bay or in making frequent repairs to pumps and lines through which the admitted sand may have to pass.

In conclusion, it is fitting to point out here that the air lift has grown steadily in favor because of certain of its well-defined merits and of its capacity to deal with situations that would greatly hamper the effective working of other systems of pumping water. Wherever the demands for water are on the increase and subject to a marked variation in quantity, such as exemplified in the case of Allenhurst, it is a matter of prime concern that the equipment adopted shall be economical, uniformly efficient, and flexible so as to be able to deliver the necessary amount of water at all seasons of the year.

Within the field of its practicable application, the air lift is said to show better economy, considering all charges; to possess greater reliability against interruption of service; to be able to increase the supply of water to meet peak loads; to follow a falling water level with only a small loss in efficiency; and to supply water of a better quality for drinking purposes because of the aeration incident to its operation.

COMPRESSED AIR TO OPERATE LOCOMOTIVES

FROM foreign sources we learn that an Italian engineer, named Tabanelli, has invented a system whereby locomotives can be operated by compressed air instead of by steam or electricity. Trial runs made before government officials late in December of 1922 have aroused great interest in railway circles and have demonstrated, so it is claimed, that the departure is entirely practicable.

The method, which requires only a small amount of crude oil and makes use of heated compressed air, promises a saving in fuel as high as 60 per cent. This factor is of great economic importance in view of the world-wide need of cutting down the consumption of both fuel oil and coal wherever possible so that essential industries, that cannot get along without either one or the other of these commodities, may have enough for their purposes. Another advantage of the system is that it can be adapted to the types of locomotives now in use with but minor changes.

THE MYSTERY OF SOUND TRANSMISSION

WHEN a great explosion occurs, with a commensurate force or volume of sound, some curious things are noted as to its audibility at different distances. There is usually a zone of audibility in the immediate neighborhood, then a zone of silence, and beyond that another zone of audibility. While an observer at, say, 50 miles may not hear an explosion, another at 80 miles may hear it distinctly.

One theory in explanation of this phenomenon is that the wind lifts the sound over an area and brings it down again many miles away. Another theory ascribes the zone of silence to the effect of the distribution of wind and temperature at high altitudes.

The International Commission for the Investigation of the Upper Air applied to various ministers of war to collaborate in the investigation of the problem, and already the Dutch Ministry of War has made arrangements for an experiment. On a day to be selected a large quantity of ammonia is to be exploded on the Oldebrack Artillery Drill Ground, and preliminary notices are to be sent out inviting observers to report.

The data to be noted are: (1) The exact standard time to the nearest second; (2) The direction from which the sound appears to come; (3) The intensity of the sound and whether easily audible to those not previously warned; (4) Character and duration of the sound; (5) Weather at the time, state of the sky, temperature, direction and force of the wind, and direction in which clouds are moving.

Japan has 117 pencil factories, with approximately $3,500,000 invested, in which are employed about 2,200 workmen. In 1918 there were exported 186,000,000 pencils.

The Castleton Bridge of the New York Central Railroad

This Bridge, With Its Associate Improvements, A Notable Railway Development

By SIDNEY MORNINGTON

ONE OF THE crying needs of the hour is less interruption to the flow of freight bound hither and thither along the transportational arteries of the country. The general welfare of the nation is being heavily penalized because essential commodities are not following the channels of distribution fast enough to meet demands.

Serious as conditions are at railway terminals, the disturbing situation is by no means confined to those freight yards. As a matter of fact, delays are occurring frequently throughout the routes of our great trunk lines, and, while this is due to a variety of circumstances, one of the outstanding causes is the bottle-necking of traffic which takes place again and again where railway activities are brought to a focus at certain cities. This is apt to be aggravated whenever trains have to run across the courses of navigable rivers.

The foregoing, in brief, sums up the railway situation at Albany, N. Y., and explains the reason for the construction of the Castleton Bridge which will, when finished in 1924, span the Hudson River about twelve miles south of the capital of the Empire State. This notable engineering undertaking, which will entail an outlay of $4,000,000 and form part of an improvement involving a total expenditure of $20,000,000 by the New York Central line, is counted upon to effect eventually a tremendous betterment in traffic conditions on the New York Central as well as on two associate roads, the West Shore and the Boston & Albany.

Today, these lines have to traverse the bottle-neck existing at the railroad gateway of Albany; and it is through this constricted traffic portal that an enormous amount of freight and passenger service must go in linking up some of the largest of our cities and in tapping a vast and very productive industrial region. Perhaps the problem presented there can be made plainer if we give a few of the facts in the case. At Albany, the east and the west shores of the Hudson are bound together, so to speak, by several low drawbridges, and the capacities of these structures have been the principal factors in determining the tonnage of freight that could be handled efficiently in and out of the yards of the State capital. Another physical condition contributing to the railroad man's difficulties has been the heavy grade westward from West Albany to Karner, N. Y., where, for a distance of eight miles, lies the steepest grade of the entire system.

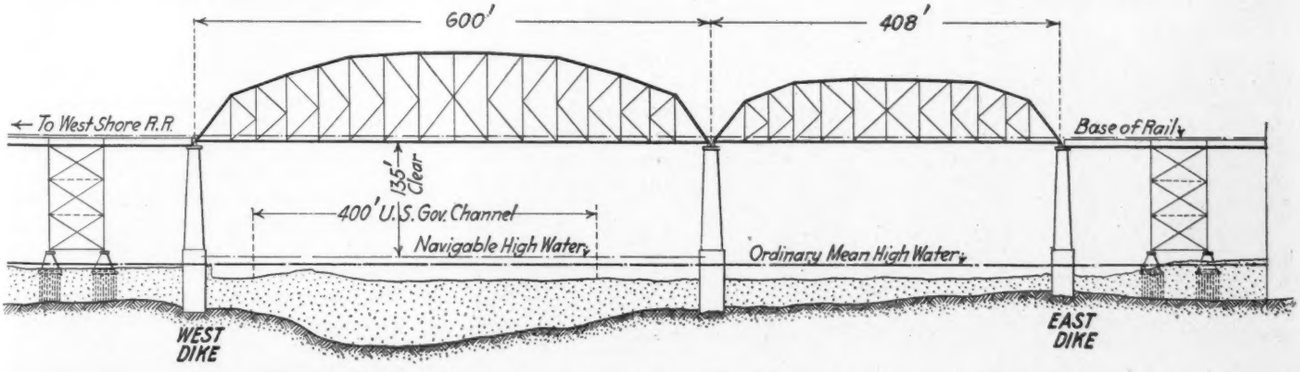
Map indicating the position of the Castleton Bridge and the new rail links by which existing routes will be interconnected south of Albany.

While it is entirely practicable to draw freight trains of 80 cars from New York City, on the water-level route, northward 140 miles along the Hudson, it is necessary before crossing the low drawbridges at Albany to break up such trains into parts. This entails switching and other delays, and each of these comparatively short sections must be supplied with an extra "pusher" locomotive for the long uphill climb westward to Karner. All too often these sections are slowed up and halted for one reason or another; and upon numerous occasions, in the navigation season, they are brought to a standstill by an open drawbridge. The reassembling of the sections imposes an additional loss of time and charge for labor. This work calls for the continual service of a score of pusher and switch engines.

Statistics reveal that the Albany drawbridges, during the busy months of water transportation on the Hudson, are turned 40 times a day, at intervals of fifteen minutes, and that they remain open each time anywhere from five to seven minutes. Thus, the railroad system is cut in two for an interval ranging from 25 to 40 minutes in each hour, and, in consequence, it is practicable to make only one-third of the possible use of the much-needed tracks. It is no rarity for trains to be kept waiting half an hour at drawbridges, and that happening when traffic is banked up on both sides of the stream.

In the past, in normal years, there has been an average interchange every 24 hours of 1,000 freight cars each way between the West and the Boston & Albany road, and a daily interchange of 600 cars with the Hudson River Division of the New York Central, and all of these cars have had to move through or encounter interruption at the "neck of the bottle." Roughly, these 3,200 cars represent in the aggregate a train about 25 miles in length which must either advance or be stopped at this gateway in the course of a single day.

We have given the preceding details in order that it may be easier for the uninformed to grasp the purpose of the Castleton Bridge and the new lines which will connect with it, and also to appreciate the relief which these will afford. Fully 23,000 tons of structural steel will be worked into the bridge, and the first steps toward the execution of the project were taken during the month of May of the year gone. Since then, very satisfactory progress

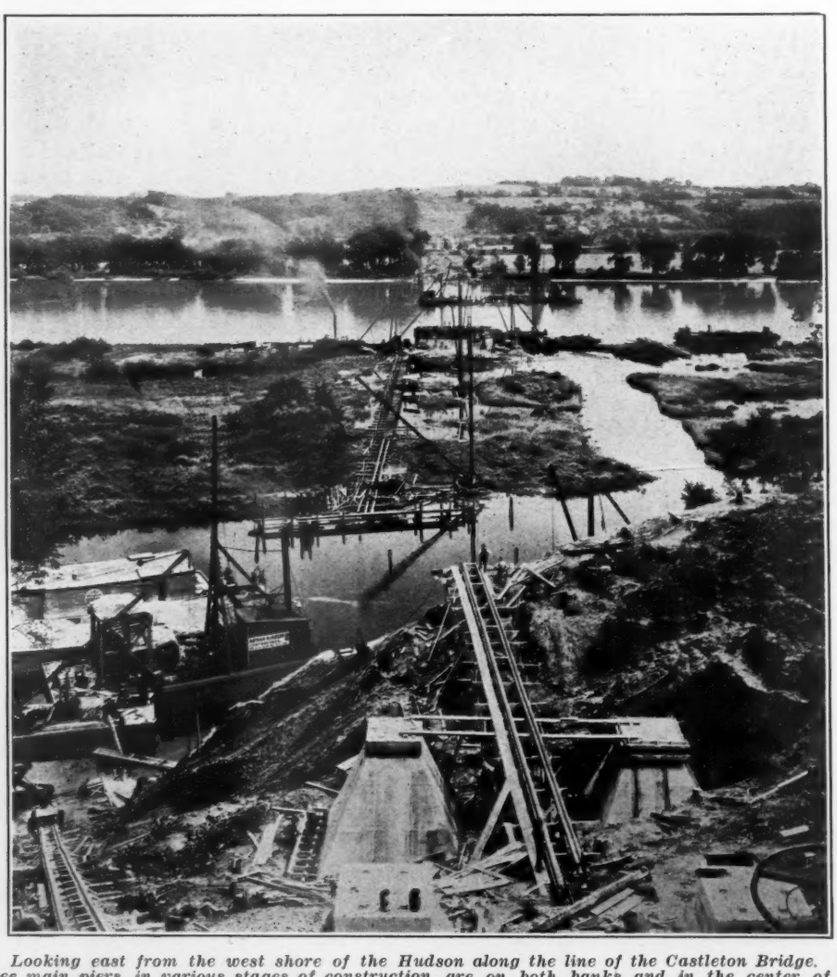


Profile of that portion of the Castleton Bridge which will span the course of the Hudson River.

Cofferdams of steel sheet piling driven around four of the smaller concrete piers forming supports for part of the eastern approach to the main spans.

has been made. The line of the bridge crosses the Hudson about two miles south of Castleton; and from abutment to abutment, on opposite slopes of the valley, the viaduct approaches and the two central spans will have a total length of a mile. The spans will be, respectively, 408 feet and 600 feet between piers—the longer or western span bridging the regular or United States Government channel. The east and the west viaducts will be supported by rectangular steel framework resting upon 100 concrete piers.

Some of the latter piers are set upon the dry ground of the valley slopes, but most of them are carried by piling driven through the low-lying marsh lands and down to rock. From an engineering point of view, the three main piers for the two spans are the most interesting, and two of them especially, those flanking the river channel, are fine examples of what can be done by means of pneumatic caissons. Before telling how these caissons were sunk, it might be well to mention here that the under-clearance of the bridge is 138 feet above ordinary mean high water—that of the Poughkeepsie Bridge being three feet less. The rails will run 150 feet above the surface of the river. At the start, the structure will carry two tracks, but the width of the floor will be ample to accommodate two more tracks whenever the volume of traffic warrants their installation.



Looking east from the west shore of the Hudson along the line of the Castleton Bridge. The three main piers, in various stages of construction, are on both banks and in the center of the stream seen in the middle distance.

The third or easternmost of the main piers, which was erected by the Walsh Company, the general contractors for the job, proved a comparatively easy task. It was necessary only to form a cofferdam of steel sheet piling and then to excavate the earth within the confined space until the underlying shale was reached. Incoming water was held effectually in check by steam pumps, and no troublesome conditions arose. The entire foundation of the pier, up to a short distance below the water level, is of reinforced concrete surmounted by a facing of granite, backed by concrete, which rises to the line of the water-table.

The center and the west piers were placed by the Arthur McMullen Company, specialists in the pneumatic work of caisson sinking. Their problem entailed getting down to 45 and to 50 feet below the river level in order to secure a satisfactory footing upon the shale. The central caisson was the deeper, but the sinking of the west caisson was the more exacting engineering task because it involved breaking through a stretch of the dike flanking the main channel on the west side of that navigable waterway. The dike was formed of a backbone of piling supported by riprap. The caisson at this point was the first to be sunk, and the procedure adopted differed somewhat from that originally contemplated by the construction department of the New York Central Railroad.

The initial step consisted of building an elliptical cofferdam, of Lackawanna steel sheet piling, having a major axis of 102 feet and a minor axis of 55 feet. Owing to the wet and unstable character of the enveloped area, earth from without the cofferdam was turned into the confined space for the purposes of providing a foundation for the caisson at the start and for equalizing the soil under the cutting edges of the caisson which was to be sunk within the cofferdam. With this work completed, the construction of the caisson was taken in hand on the spot.

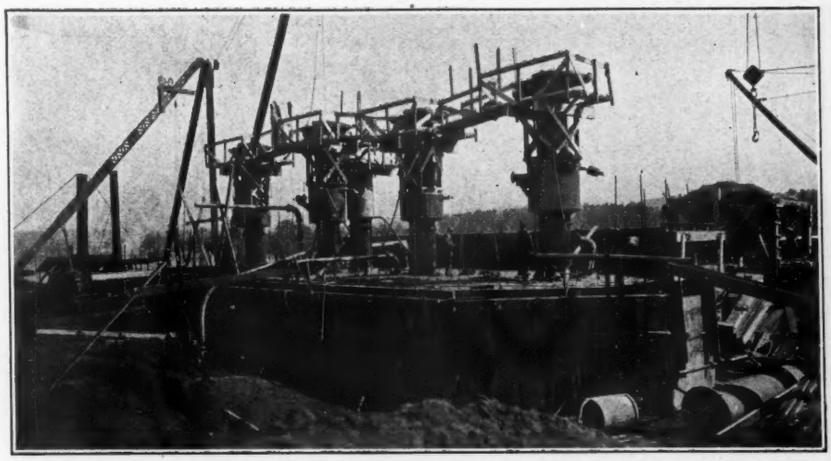
The primary plan called for steel caissons, but the contractors were able to show that a saving in time and expense could be effected by substituting caissons of reinforced concrete. The latter were adopted, and were designed throughout by the McMullen Company. The west caisson, which is practically a duplicate of the center caisson but five feet less in height, is an elongated octagon in plan—having

a length of 86 feet, a width of 35 feet, and a total height of 40 feet. Steel forms were used for the exterior and wooden forms were employed for the interior of the caisson; and the structure was made up of superposed sections cast successively from five to ten feet in vertical thickness. The working chamber was divided into four compartments by three interposed, heavy, transverse bulkheads of reinforced concrete having openings in them to facilitate the free movement of the sand-hogs. The cutting edge was reinforced by ⅜-inch steel plating. Each of the compartments had its own mucking shaft and excavating lock—the shafts having an internal diameter of three feet. There was a fifth shaft which was used by the men in descending to or coming up from work in the pressure chamber. Excepting the latter chamber and the vertical passages just described, the caisson was a solid mass of concrete and reinforcing steel bars carefully disposed to insure a maximum of rigidity. By the time the caisson settled on the underlying shale it had a total weight of between 7,000 and 8,000 tons.

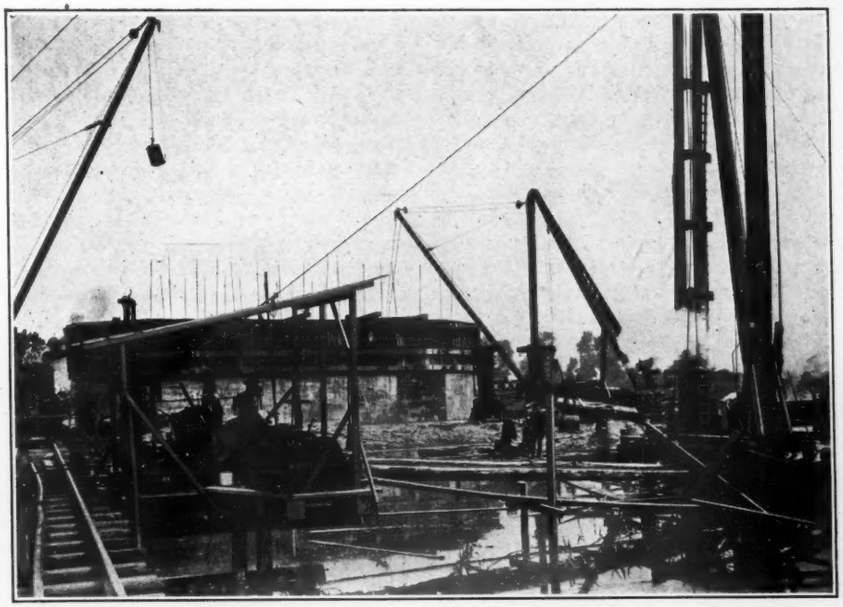
Inasmuch as the workers in the pressure chamber encountered for the most part only river sand, the sinking of the caisson proceeded steadily and uneventfully, and the total period of descent was inside of four weeks. Some mucking was done by blowing, but most of the excavated material was carried up through the air-locks. In order to insure satisfactory lodgment, some soft shale was removed by drilling and blasting before the cutting edge came to rest upon a stratum of harder rock. Twenty sand-hogs constituted a shift, and their time under pressure varied from eight hours, in the earlier stages of the job, to six hours when the second zone was reached. The work was carried on continuously, night and day.

Air for the pneumatic operations was supplied by a battery of three steam-driven, Norwalk compressors having a combined output of 2,000 cubic feet of free air per minute. As a matter of fact, the requirements were fully met at all times by not more than two of the machines—the third compressor constituting a reserve unit. When the excavating was finished, the regular air-locks were removed and concrete locks were secured in their stead to the mucking shafts. In this way, the four compartments of the working chamber were filled with concrete, which was thoroughly distributed by hand. Finally, the remaining cavities immediately beneath the shafts and in the shafts, themselves, were closed with concrete, which settled in place by gravity. Thus the caisson in the end became a single, solid, granolithic mass bound securely to the supporting ledge of shale.

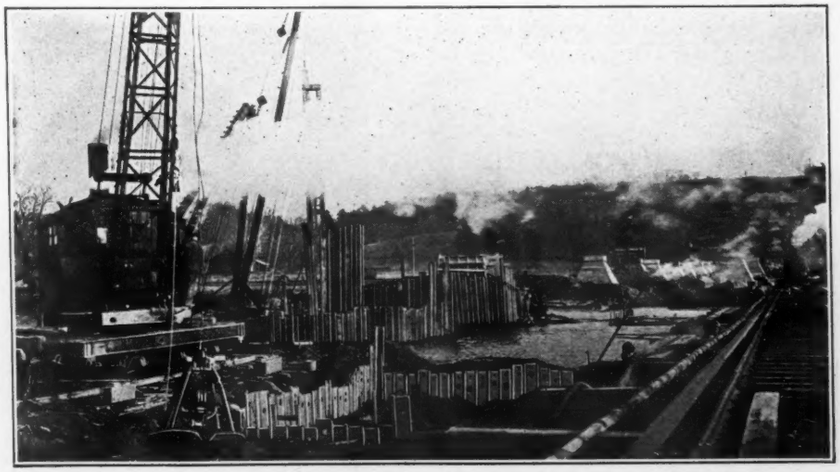
The procedure in the case of the center caisson was, for all practical purposes, a repetition of that employed in dealing with the west caisson; and the structure has its footing on shale 50 feet below mean high water. Each of the two foundations formed by the sunken caissons is surmounted by a granite facing, which extends from ten feet below to fifteen feet above water, and the space inside is filled with concrete. From the top of the stonework, that is the water-table, there is being reared



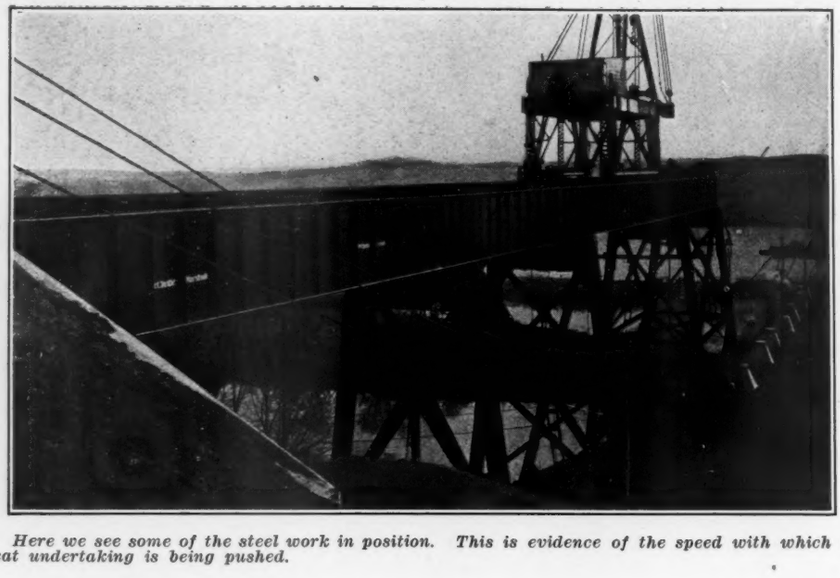
A close-up of the great concrete caisson on the west bank of the river during the last stage of its sinking. The four large locks are mucking locks, and the fifth and smaller one is the man lock by which the workers descended to and rose from the pressure chamber.



The caisson which was sunk on the west bank of the river. The picture was taken when the structure had a height of seventeen feet above the cutting edge. As this caisson settled, additional sections were added, and these ranged from five to ten feet in height, depending upon conditions.



Driving steel sheet piling in forming cofferdams within which some of the concrete piers on the east side of the river have been erected.



Here we see some of the steel work in position. This is evidence of the speed with which the great undertaking is being pushed.

a solid, reinforced concrete shaft which, when completed, will be 120 feet tall. A third and similar shaft will be carried by the eastern main pier; and it is upon these three piers that the burden of the two big steel spans is to be distributed.

On the west side of the main course of the Hudson, the viaduct crosses an estuary in which the water is about eleven feet deep, and it was necessary to construct there four reinforced concrete piers of moderate dimensions. This work was done inside of a single cofferdam, built of steel sheet piling, which was kept drained until the piers were well above the normal water level. As will be realized, these piers differ from the other viaduct piers located in the water-bearing soil of the lowlands in that they are not carried upon piles driven down to rock but rest right on the shale.

Now for a brief description of the branch lines by which the bridge will be linked with the existing system. All told, there will be twenty miles of these rail connections, and the route planned for them will cross highways at 24 points, sixteen on the east shore and eight on the west shore of the Hudson valley. These crossings will pass below or above the grades of the vehicular thoroughfares, and, therefore, none will cross at grade. To the west of the Castleton Bridge, the new trackage will extend inland across level farmlands and join the West Shore Railroad at Feura Bush, where there will be created a mammoth, gravity freight-classification yard.

On the east shore, the tracks will run for four miles with very slight grades and connect with the Boston & Albany Railroad at VanHoesen, N. Y. The third lateral will make connection with the New York Central main line just south of Stuyvesant, N. Y.; and the new tracks will skirt the bluffs for twelve miles southward from the bridge so as to insure an easy gradient. The fact that trains will not have to climb steep slopes at any time upon the so-called Hudson River Connecting Railroad makes it clear how much less of a haulage tax will be levied upon the locomotives than is now encountered on the long upgrade pull westward from Albany to Karner.

The new cut-off provides substantially level connections throughout, the maximum grade at any point being only 35/100ths of 1 per cent. This will make it entirely feasible to handle solid 100-car freight trains between Chicago, Boston, and New York City terminals when traversing both sides of the Hudson River. The new links are expected in the future to carry a burden of freight equaled by few stretches of track in the world; and all essential contributive facilities have been planned with this in view.

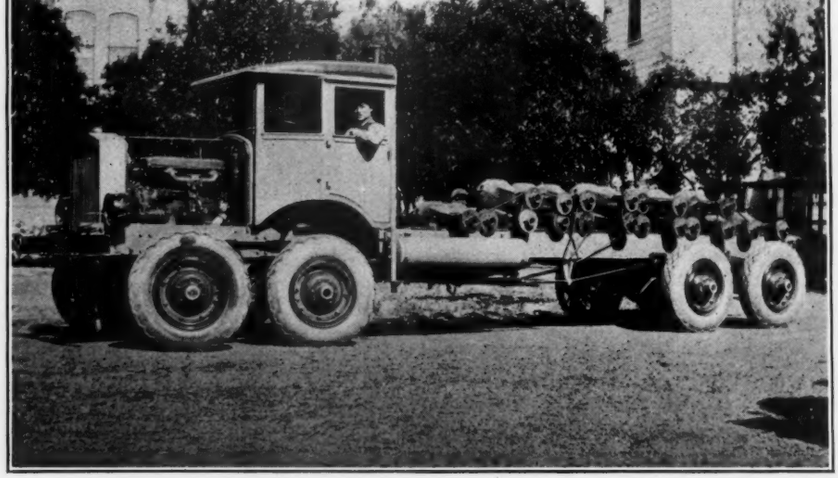
The improvement will include the creation of one of the greatest and most up-to-date gravity freight-classification yards in existence. At Feura Bush the multi-track yard will be six miles long, and there freight cars may be assorted into solid, eastbound trains moving either down the West Shore tracks for direct deep-water trans-shipment at Weehawken, N. J., or across the new bridge to the New York Central main line for delivery to the freight terminals on Manhattan Island, or they may connect by easy grade with the Boston & Albany and thence go on to points in New England. In short, at Feura Bush may be concentrated the classification work now carried on in the smaller and inadequate yards at West Albany, Karner, Ravena, and other points—in this way eliminating a vast amount of lost motion.

EIGHT AIR BRAKES ON AN EIGHT-WHEEL TRUCK

THERE HAS recently been developed a fast freight truck that has eight wheels, each of which is equipped with an air brake. This truck is intended for long-distance highway transportation. The four rear wheels drive while the four front wheels steer. The truck is equipped with 36x8-inch pneumatic tires. The claim is made that it is capable of making a speed of 30 miles an hour while loaded and that it is under perfect control at that speed. The further claim is made that there is less damage from this type of vehicle passing over the highways than there is from a 2½-ton truck with solid tires.

The two front axles are connected by springs, so arranged on either side that the axles oscillate about a central trunnion bar. If one tire blows out—indeed if the whole wheel comes off—the loss is so taken up by the inter-relation of the four wheels of the front set that the steering ability is not materially affected. Another new feature is a transmission providing eight speeds forward and two reverse. Safety for passengers on buses equipped with eight wheels is assured by the low center of gravity, the constant traction, and the eight air brakes for stopping in case of emergency.

Highway commissions are becoming more strict in their provisions for the protection and the preservation of expensive highways. The 8-wheel vehicle has the decided advantage of lessening the weight per wheel.



An 8-wheel truck which is equipped with air brakes on all of its wheels. This is the forerunner of a very significant departure in highway transportation.

A NOVEL FLUME BUILT IN MOUNTAINOUS REGION

By S. R. WINTERS

GUNITE, a mixture of Portland cement and sand applied by compressed air with a cement gun, employed in conjunction with concrete in constructing a 52-mile canal in south central Idaho, has demonstrated its efficiency in forming a water-carrying flume resting on an unstable foundation. Built by the Reclamation Service of the United States Department of Interior about two years ago, this canal is probably the first of its kind in the country, and, today, offers no evidence of settlement despite its erstwhile insecure bed. The purpose of the flume is to convey water to arid acres and to transform them into fruitful fields.

The Federal Government used both gunite and concrete experimentally in constructing the 3,300 linear feet of flume in the Snake River Canyon, but after two years of service the responsible engineer has placed his stamp of approval on the new type of canal. It has proved to be water-tight, and no erosion of the foundation is apparent. The flume crosses numerous gulches and creeks, and spans the treacherous Snake River four times.

Owing to the nature of the terrain, the application of the gunite offered some difficulties. The compressors, instead of being spaced at intervals along the bench of the flume and moved as the work progressed, were made stationary at a suitable point on the bluff of the canal; and the compressed air was conveyed by pipe lines to the cement guns. The maximum distance at any time between the point of operations and the air compressors was 2,200 feet. This departure from ordinary practice was not made in the interest of efficiency: it was an emergency measure.

The narrow bench or pathway alongside the flume rendered it impossible to shift the air compressors from point to point as building activities forged ahead. It was also impracticable to transport the compressors along the bluff above the flume. So restricted was the passageway that no road could be constructed over which the needful equipment and materials could be hauled by teams of horses or mules. The steepness of the hillside on which the bench was located was such as to preclude approach save from each end. The threadbare adage, "Necessity is the mother of invention," reasserted itself, and the engineers in charge built a 36-inch gage railroad, bridging ravines and canyons, parallel to the flume. The diminutive train ran to and from a centrally situated concrete mixing plant, where a pit with an abundance of sand and gravel was available. At this plant two mixers were in operation, one mixing concrete and the other forming a mixture of dry sand and cement for use in the cement guns.

This picture gives a fairly good idea of the way in which the reinforcing steel rods were placed.

The 52-mile canal was given a concrete and gunite floor having a thickness of five inches, while the side walls vary in thickness from 2½ inches at the top to four inches at the bottom. The inside dimensions of the channel are eight feet seven inches by five feet, and the flume has a capacity of 268 second-feet with a freeboard of one foot. The gunite was composed of one part of cement to five parts of sand. However, as 20 per cent. of the sand was sacrificed to rebound and as scarcely any of the cement was lost in this way, the gunite actually in place is in the proportion of one to four. A highly refined concrete sand, obtained at the central mixing plant, was originally employed in the gunite composition. The rebound, however, reached the exceptionally high loss of 30 per cent. of the total aggregate and consisted chiefly of the coarser particles. Subsequently, experiments indicated that the rebound could be decreased by the addition of hydrated lime, and that this decrease is in proportion to the quantity admixed, which may be up to a ratio, by weight, of one part of lime to ten parts of cement.

Structurally, this water-carrying channel, which hugs precipitous slopes far above the river, involved some interesting engineering details. A double row of longitudinal reinforcing steel was embedded in the floor of the flume, thus affording a wider spacing of the bars. In the absence of this provision the bars would have been so closely knit together as to render it difficult to properly place and to tamp the concrete. The transverse bars, in the floor, bend at right angles, and extend through side walls which are reinforced as vertical cantilevers. Supplementary reinforcing steel was employed in the bank wall as an added means of fortifying it against external pressure exerted by blow-sand accumulating behind the flume. The use of gunite permitted a reduction in thickness of the side walls at the base from five to four inches. This, in turn, called for the employment of less longitudinal or temperature steel, as the amount of the latter is based on the percentage of the total area of gunite.

The canal was designed with sufficient temperature steel to compel the concrete to crack at intervals of six feet. The percentage of steel in relation to the gunite was determined on the assumption that, since the flume was built during the late autumn, the steel would be subjected to a temperature of 70°. Accepting this figure as true, it was calculated

Placing the concrete for the floor of the flume. The mixer is mounted on a car which is moved from point to point by a small locomotive. Note the tortuous course taken by the flume in skirting the sides of hills, and in crossing valleys and streams.

A finished section of the irrigating flume and a general view of the character of the country through which this novel artificial waterway runs.

that ½ to 1 per cent. of steel would be necessary when using ¼-inch bars with an elastic limit of 55,000 pounds to the square inch. After the canal had been in operation for a considerable period, observations revealed the appearance of fine hair-cracks at more frequent intervals than six feet. These fissures, ordinarily, occurred at 18-inch intervals, and at points where the gunite was reduced and weakened by the vertical bars.

The lower three inches of the side walls were fashioned of concrete and were poured integrally with the floor of the flume. This created a curbing against which the forms for the gunite side walls could be placed and maintained in true position with respect to line and grade. A 4-inch tile drainage system was provided. The forms for the walls of the flume consisted of inside panels, constructed of ship-lap, with an arrangement of cross-bracing to secure them in alignment. As no pressure was exerted by the gunite this simple framework was readily installed. A top templet was all that was necessary to make the panels conform to alignment, inasmuch as the bottom was held secure against the concrete curbing by use of spreaders between the panels. Once the forms were placed and braced, a 1-inch board, which was straight for the tangent and cut to the proper radius for the curves, was nailed along the top. This arrangement was subsequently discarded, as it was discovered that rebound material would collect beneath this top board. When the forms were removed this deposit would brush off and leave an unsightly top. The gunite was sprayed directly against the vertical wall and smoothed off with a steel trowel.

The reinforced steel, which was placed subsequently to the preparation of the sub-grade and the installation of the drainage system, was cut and shaped at a centrally located yard. The concrete was carried from the nearby mining plant to the flume in 1-cubic yard, side dump-cars. Their contents were discharged by gravity onto the floor of the canal. After the concrete floor had dried sufficiently to permit workmen to walk on it without injuring its surface, the framework for supporting the steel was assembled, and then the gunite forms were erected. The aggregate for the gunite, mixed dry in a concrete mixer, was sacked in batch quantities and conveyed from the centrally located plant on flat cars to the cement guns. The latter were mounted on a flat car and were moved along the track, remaining within 50 feet of operations at all times. The cement guns were kept together, a nozzleman working on each side of the flume; and one crew fed both machines. The entire operation was supervised by one foreman, and fewer laborers were required than if the work had been done in the usual way.

When making the side walls, the application of the gunite began at the bottom and was carried upward. The rebound was thus permitted to escape with a minimum chance of burying any of it in the wall. Gunite, which has a tendency to build upon whatever it strikes, could not be sprayed at right angles against the wall until the spaces between the steel and the forms had first been filled. Square bars were objectionable in this connection as it was found impossible to fill in the spaces between the bars and the forms and thus to insure entirely embedding the bars. Excess water in the gunite, as well as the application of too great a thickness at one time on a vertical wall, caused the material to sag and to slough off, leaving cracks along the horizontal bars.

The experience gained in building this canal indicates that the walls should be constructed in layers of from 1½ to two inches, and of gunite having a reasonable moisture content. Each coat should be permitted to set a while before the succeeding one is applied.

According to the Geological Survey, very nearly 2,000,000 tons of sand is used in the United States annually in the manufacture of glass.

Norway depends largely upon imports for its supply of paints and varnishes.

COLORED BITUMINOUS PAINT

BITUMINOUS paints of a fairly wide range of colors are something quite new, and they have only recently been put on the market after many years of experimenting. The inventor, however, has not only succeeded in producing yellow, brown, chocolate, red, blue, slate, black, dark and olive green paints of this description, but he has also turned out a compound which can be used either as a priming or a finishing coat.

The paints come mixed and ready for use—they need only be stirred before application. According to the claims made for them, "No preparation of the surfaces to be coated is necessary as the bituminous compound adheres readily to new galvanized iron, steel, tin, etc., and, no matter what the material to be painted may be, it does not have to be given the familiar red-lead priming coat. This is a step in the direction of economy, as all of the painting may, therefore, be done by the spray method which greatly cuts down the cost of application.

"Tests made under all sorts of conditions have proved the paints to be very durable and to have great powers of resistance when exposed to heat, ice, salt water, and to the fumes of sulphur, ammonia, and other chemicals. They are especially suitable for use in tropical countries; and they stand up well in dark and damp places and when subjected to the extremes of hot and cold weather."

PREVENTABLE ACCIDENTS

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IT HAS of late been forcefully brought to the writer's attention that most accidents are "common" accidents. When the annual number of accidents and their nature are compiled by statisticians it is found that most of them can be covered under certain "common" headings.

In spite of the warning notices in factories, on streets, and at bathing beaches all over the world, and notwithstanding the "Stop, Look, Listen" signs we see every day at railroad crossings, we read the "common" news nearly every day that someone has been killed by a locomotive or an automobile, or has been drowned, etc. Despite all the articles that have been written about boiler explosions, the evils of grease in boilers, low water level, scale, poor design, etc., engineers are still inclined to ignore the warnings. They allow oil deposits to accumulate, permit scale, do without good automatic regulators, and subject themselves to continual danger.

If most accidents were "uncommon" accidents, excusable accidents, accidents not caused by negligence of the person killed or injured, it would not be so bad. However, in many if not in most cases, the maimed or killed person has himself to blame. It is regrettable that this is the truth, and it seems that the only thing to do to reduce the number of preventable accidents is to continue present educational methods and to keep on preaching "Safety First." Warnings must be repeated, and repeated, and repeated; and it is certain that without such cautionary notices the total casualties per year would be even greater than they are at the present time.

Modernizing the Distilled-Water Ice Plant

This is a Subject of Interest to Many Operators of Ice-Making Installations

By ROBERT G. SKERRETT

THE MANUFACTURE of ice is in a state of flux owing to outstanding improvements which have been made recently in the mechanical equipment required by this expanding branch of industry.

Things that were deemed doubtful of accomplishment a comparatively short while back are now well established in practice; and certain betterments offer opportunities for very substantial savings in money and in time.

It was not so long ago that the belief prevailed in the ice-making business that distilled water was absolutely essential to the production of a satisfactory, marketable product. And a casual survey of the industry discloses that a large percentage of the ice plants in the country still continues to use distilled water in its operations.

But the tide is turning, and there is ample warrant for the assumption that this state of affairs will be radically altered in the near future. Year by year competition grows keener and keener in the ice-making field; and the survival of many of the existing plants will hinge upon their adoption of up-to-date equipment.

The refrigerating engineer can now give definite assurances that it is commercially feasible to manufacture "clean" ice from raw water and to turn out a better product in some respects than is customary in the making of distilled-water ice. Not only that, but by employing the raw-water method it is possible to realize marked economies that could not be obtained by the older system. This is not to be wondered at if we pause for a moment to consider some of the factors involved in the distilled-water process.

THE purpose of the accompanying article is to point out in a specific case what are the gains that can be made by transforming a distilled-water ice plant into one using raw water in the manufacture of ice.

Only in a suggestive sense do the figures quoted apply to the industry at large. It is fully recognized that each ice plant contemplating a similar change must be studied separately. The broad subject, however, is one that is now engaging the attention of many of the people in the ice industry.

The distilled water that is utilized in the manufacture of ice is the result of condensing exhaust steam that has served in driving the prime mover and certain of the auxiliaries of the plant. This water has to be reboiled and carefully filtered to remove any traces of oil before it can be placed in the ice cans for freezing. The ability of a distilled-water ice plant to make anything in the way of a record in efficiency depends in the main upon the economies which may be realized in the boiler-room.

It is well known that the average boiler does not evaporate more than six to seven pounds of water per pound of coal burned in the furnace. Next, there are heavy losses which occur in a distilled-water plant during reboiling, in the overflow from traps, and in other stages of the water's necessary treatment. In these circumstances, an ice plant of this kind cannot, as a rule, make more than five tons of ice for each ton of coal consumed. With coal selling around $7 a ton, the actual fuel cost per ton of ice is, therefore, $1.40.

Should coal cost less in the future, conditions would remain relatively the same so far as a comparison with electric drive is concerned, because the cost of current, in the last analysis, is always based upon the price of necessary or competing fuel.

To the foregoing outlay for coal must be added a fire-room labor charge, ranging from twelve to 25 cents per ton—according to the size of the installation. Further, an allowance must be made for depreciation and for repairs on the steam plant, and there must also be considered the interest charge on the boiler-plant investment. These various items represent an aggregate expenditure of from $1.80 to $2 per ton of ice produced, so we are authoritatively informed. The foregoing figures do not include the charges pertaining to the engine-room force, engine upkeep, the pay of the can pullers, and the repairs incident to the proper maintenance of the strictly ice-making department of the establishment.

For the sake of those unfamiliar with the history of ice making, it should be mentioned here that the original reason for the use of distilled water was to obtain clear instead of white ice. Distillation serves to eliminate the air held in solution by ordinary water; and by doing this the water has no free air in it to gasify and to

A general view, from the west, of The Lancaster Ice Manufacturing Company's refrigerating plant and cold storage house. The ice-making equipment is located in the frame building at the right.

The switchboard controlling the electrically driven Ingersoll-Rand ammonia compressor.

form bubbles during the freezing period. It is quite erroneous to assume that the employment of distilled water obtained from exhaust steam insures a hygienic commodity. Indeed, it is no unusual thing for the distilled water to contain organic matter carried over from the boiler; and this explains why the core of a cake of distilled-water ice not infrequently emits an unpleasant if not a noticeably foul odor.

Before taking up the further consideration of our subject, we might emphasize at this point that clean or clear ice can be manufactured today by the raw-water method which avoids, at the same time, the objectionable characteristics of distilled-water ice. This is accomplished by jets of compressed air discharged in the raw water; and their action, as the air streams rise, wipes away the bubbles liberated from the water during freezing and thus prevents the entraining of these bubbles in the forming ice. The raw water can be obtained from any source that satisfies hygienic requirements, and its purity is more easily susceptible of control in a commercial undertaking than is the case in the handling and the filtering of distilled water obtained from exhaust steam.

Now let us consider the other aspect of the problem and see what a thoroughly modern equipment makes practicable. To give greater force to our presentation of the subject, let us quote an eminent refrigerating engineer, Van Rensselaer H. Greene. "Due to the remarkable load factor which the average up-to-date ice plant gives, the electric power companies have seen fit to establish a special current rate for ice-plant users; and in most cities the rate for service of this kind varies between 1.3 cents and 1.25 cents per kilowatt-hour. In a properly designed plant, experience reveals that it is possible to produce a ton of ice on an electrical expenditure of from 50 to 60 kilowatt-hours per diem, depending upon the temperature of the water used for condensing the ammonia gas. In brief, the power cost for current may run between 75 cents and 90 cents per ton of ice—local conditions controlling the actual outlay.

Ice is dumped simultaneously from a group of ten cans which are handled by one of two electrically driven traveling cranes.

"Statistics show that it is possible, when current can be bought at the figures given, to save approximately from 75 cents to $1 a ton by converting a distilled-water ice plant into an electrically driven raw-water plant, and this saving is ample in most plants to cover the cost of remodeling within a period of three years."

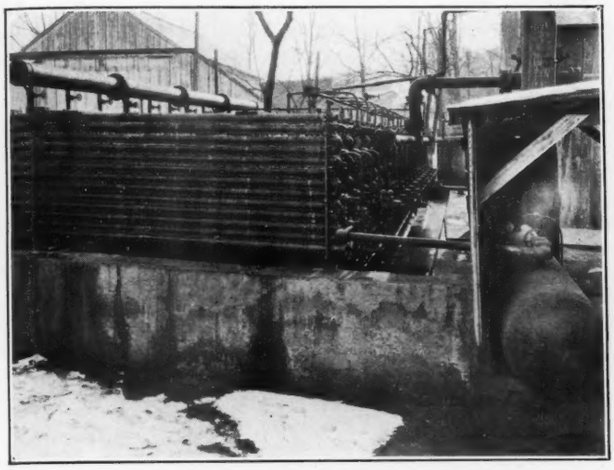
In changing a distilled-water plant to one operating on raw water it might be well here to give a word of warning. The conversion must not be carried out in a half-hearted way. It may prove costly and, in the end, rather disheartening if the remodeling, so called, results in an uneconomical combination of old and of new features.

As has been explained by a well-known expert, a steam pump which leaks more or less will not materially affect the coal consumption of a steam plant wherein there is a general prevalence of kindred wastefulness. On the other hand, in an electrically driven ice plant, where every bit of energy consumed is metered, even such an item as excess friction on the bearings and packing of piston rods of the compressor will promptly influence the power costs of the establishment. And the ultimate economies in operation will be largely determined by the care exercised in selecting the type and the method of drive of the auxiliaries. In well-nigh all cases, excessive kilowatt consumption per ton of ice is largely chargeable to wasteful auxiliary equipment; and no plant should be electrified before a thorough study has been made of the percentage of power required to operate the auxiliaries.

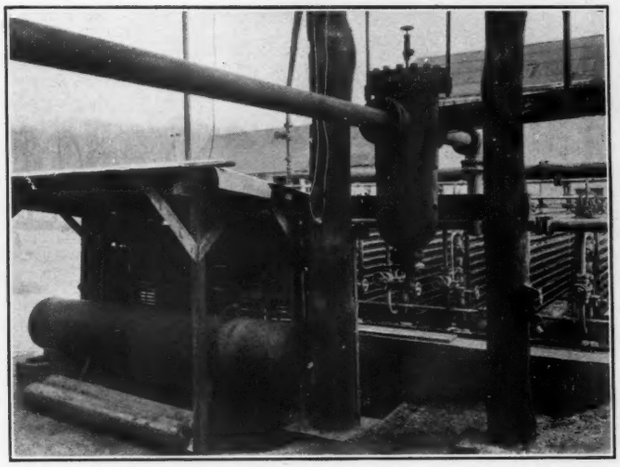
At the risk of dwelling over long upon this broad subject of the total power consumption of a plant, another word of caution might not be out of place here. There is a growing tendency to motorize existing steam-driven compressors simply by removing the steam cylinders and the connecting rod and by driving this compressor by means of a belt or a chain, or by installing a special motor which shall possess the requisite flywheel characteristics of the flywheel, which it is intended to supplant.

If either of the latter expedients be adopted, care should be exercised to determine the right speed at which the compressor should operate. This is essential in order to insure the proper functioning of the compressor valves. If the machine should run too slowly, then its full capacity cannot be obtained and the cost of the motor will be prohibitive. This is due to the fact that the cost of the motor increases inversely and rapidly as its speed of operation decreases. On the other hand, if the motor adopted is designed for over-high speed as compared with the designed speed of the ammonia compressor, then the suction and the discharge valves of the compressor may—by reason of their type and their heavy weight—not be able to accelerate fast enough to perform efficiently. In such a case, this will lead to excessive leak-

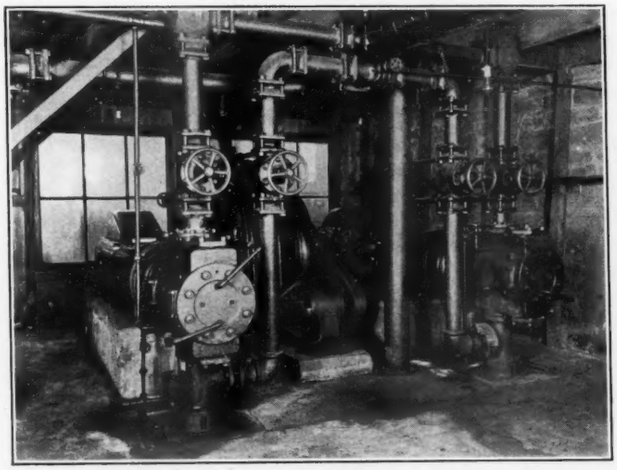
Features of the Ice-Making Plant and Cold Storage Rooms



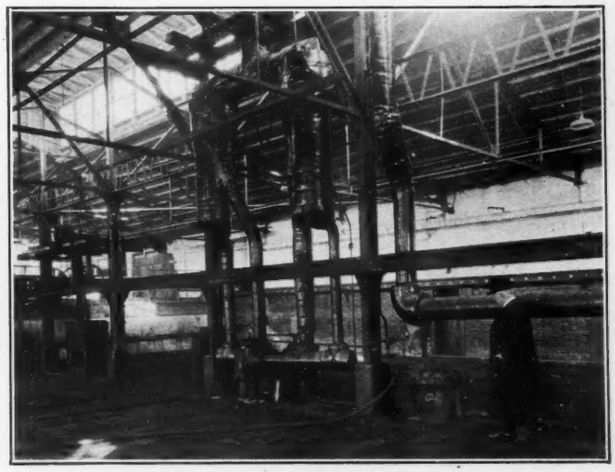
The ammonia condenser coils which are cooled by well water. The three rear coils are used to cool the distilled water.



At left, the ammonia receiver and tanks containing anhydrous ammonia. The trap in the ammonia system is suspended between the poles.

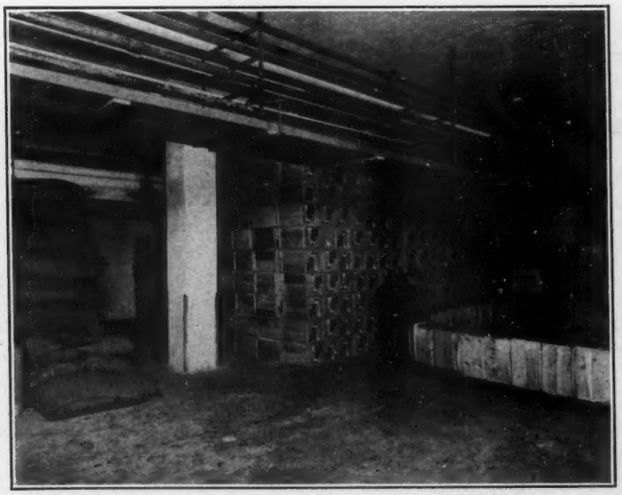


The electrically driven, direct-connected "Imperial XB" ammonia compressor. This machine has a refrigerating capacity of 110 tons.



The tank-room. The table-like apparatus in front of the man is a paper-disc filter through which the water passes before entering the cans.

Boxes of choice apples from neighboring farms in The Lancaster Cold Storage House. The temperature is around 30°F.



Nuts and California fruit in cold storage. A portable roller runway facilitates the handling of incoming and outgoing packages.

Barrels of "native" apples awaiting distribution. The pipes overhead are white with accumulated frost.

age and, in all likelihood, to the ultimate breakage of these operative parts.

The present article has been inspired by the situation at the plant of The Lancaster Ice Manufacturing Company, Lancaster, Pa. This concern has been in business for the better part of 30 years, and, as might be expected, it has up to the present been operated on the distilled-water system. The management, however, has decided to modernize the equipment and to fit the plant to run on a raw-water basis.

This enterprise is in keeping with the dominating position which the company holds within the area served by it, and is also a reflex of the increasing demand for ice which might be expected in so thriving a city as Lancaster. Lancaster boasts a population of more than 53,000; and it is located in what is considered the richest of Pennsylvania's agricultural counties. The farms thereabouts produce large quantities of foodstuffs, and some of the most delicious apples are grown in the neighboring orchards. No inconsiderable percentage of these commodities is held in cold storage for deliberate distribution; and the cost and the effectiveness of this service depend fundamentally upon the refrigerating and the ice-making facilities locally available.

The Lancaster Ice Manufacturing Company, in addition to making ice, also operates the associate Lancaster Cold Storage House. This has a total capacity of 275,000 cubic feet. The main portion of the cold storage house is about a decade old, but additions have been made within the last two years. The temperatures maintained within the different rooms where, for the most part, fruit is now held, range between 29 and 30°F.

The ice-making or refrigerating plant consists of a single cylinder, consolidated Corliss engine, of about 300 H.P., driving two vertical York compressors having a combined refrigerating capacity of 100 tons. This outfit has been a part of the plant for years. Within the past fifteen months, the equipment has been amplified by the addition of an Ingersoll-Rand ammonia compressor, "Imperial XB" type, of two cylinders, each of 10x14 inches. This modern machine is electrically driven by a direct-connected, General Electric synchronous motor of 225 H.P., which has a speed of 250 R.P.M. A third and standby ammonia compressor is available. This machine is belt driven from an electric motor. It is of a decidedly obsolete pattern.

While either distilled-water ice or raw-water ice is equally satisfactory in an ice-box or refrigerator, there is a noticeable difference between them when otherwise employed. As most of us know, distilled water, unless thoroughly aerated, is rather flat in taste, and ice made from it, if placed directly in a drink will impair its palatability. Raw-water ice, however, has not this drawback and is, therefore, more acceptable for use in restaurants, by soda fountains, in the home, etc.

The Lancaster Ice Manufacturing Company's plant is located in the southern outskirts of the town and on a bank of the Conestoga River, from which it obtains water for its boilers and, incidentally, for ice making. The Conestoga has changed greatly since Robert Fulton conducted some of his engineering experiments on it. Its waters are now seriously polluted, and the stream is therefore unsuitable as a source of water for the direct manufacture of ice. It is made fit for this purpose only by the boiling and filtering treatment it now undergoes. Let us describe briefly just how water from the Conestoga is dealt with before it is allowed to enter the ice cans in the tank-room.

Exhaust steam, which is discharged either from the Corliss engine or steam pumps, is delivered first to a condenser where the steam is chilled and water precipitated. This water, while still hot, is passed on to a reboiler equipped with a steam coil. After leaving the reboiler, the water is fed by gravity into a skimmer which takes off grease, etc.; and from the skimmer the water is pumped to condensing coils which are situated nearby and outside in the yard. Upon issuing from the cooling coils just mentioned, the water is piped to a so-called sweet-water tank, whence it percolates through one of two coke-and-sand filters. Finally, the water is led from these filters to a paper-disc filter, placed centrally on the floor of the tank-room. This filter connects by hose with the automatic can fillers. The foregoing recital should make it clear to anyone familiar with the transmission of steam or hot water how many chances there are for losses of water and of heat by radiation—both losses representing in the present case a wastage of fuel.

There are on the property two deep wells, which are equipped with electrically driven rotary pumps. This water is today used principally for cooling the coils of the ammonia condensing system. When the plant is equipped for producing raw-water ice, it is said that these wells will be drawn upon to furnish the needful water. It is not unlikely that the river water will then be employed for condensing purposes, if that be needful in order to save the supply in the wells to take care of the demands of the tank-room. That is, the present procedure will be reversed.

The tank-room is divided longitudinally so as to form two freezing tanks, and each of these has a capacity of 500 cans. It takes from 42 to 44 hours to turn the 300 pounds of water in a can into a block of ice of the same weight. Owing to the sequence in which the cans are filled with water and the ice is formed and removed from them, it so happens that it is practicable when the freezing is in full swing to lift out twenty cans every 50 minutes—ten cans from each of the tanks. There are two electrically operated traveling cranes which run the length of the tank-room, and each of these is equipped with an electric hoist arranged to handle ten cans at a time by means of a suspended I-beam with pendant chains and hooks. The daily output of ice is about 90 tons. The brine in the two tanks is circulated by four electrically driven paddles—one at each end of each tank. Adjacent to the north end of the tank-room is an ice storage room, which usually carries from 800 to 900 cakes.

Current for the operation of the electrical features of the plant is obtained from the great hydro-electric power station at McCall's Ferry, on the Susquehanna River, about eighteen miles away. There is every reason to believe that the management is fully justified in scrapping all of the plant's existing steam equipment and in starting afresh with full electric drive. The records of kindred enterprises that have changed over from distilled-water to raw-water ice making have revealed very substantial operative economies. In fact, the gains have been such as to wipe out the expenditures incurred for this purpose in the course of three or four years.

Nothing contained in this article should be construed as a sweeping criticism of steam-operated, ice-making machines. A thoroughly efficient steam-driven ice plant is practicable; and there are many in service today situated where fuel can be had at a price that makes the running costs lower than would be the case if electric current were bought at the rates available. The choice of electric or steam drive must, therefore, be determined by local conditions.

OVER-PRODUCTION OF RUBBER

IT IS not very long ago since the industrial world was foreseeing serious trouble from a shortage of rubber. The demand had grown and was continuing to grow so rapidly that it seemed production would never be able to catch up.

The worry is now all the other way. Chiefly from English sources we learn that the rubber-growing industry is in a critical position as a result of the over-production of the plantations. The surplus yield for the past year is estimated at 25 per cent., while the stocks in existence in January of 1922, were 50 per cent. above normal requirements.

A proposition is being considered for the stabilization of the industry by the creation of an International Plantation Rubber Company, with a capital of about $250,000,000. The total capital now invested in the production of crude rubber is estimated at $750,000,000.

The construction of the so-called Shimonoseki Tunnel, which is to connect two of the larger islands of Japan, is estimated to involve an outlay of several million dollars. The bore, which for the most part will run through solid rock, will be more than a mile in length. The contract for the work, so it is said, may be awarded to foreign builders.

Silencing Air Compressor Intakes

By HIRAM PERCY MAXIM

NOISE used to be accepted as an unavoidable feature of communal life. Few if any of us gave heed to the possible ill effects of noise upon physical well-being. We talked about the quiet of the country, and took as a matter of course the racket of city streets and the hum of industry.

Sleep is absolutely essential to health; and, to a degree, a measure of quietude is needed by the nervous system and to make mental concentration practicable. The medical fraternity now recognizes the damaging potentialities of loud and frequent noises; and there is a growing insistence that many of these sounds be either muffled or done away with entirely.

Mr. Maxim, who has achieved so much in this general field, tells in the present article what he has done and is doing to effectually silence a variety of these disturbances.

WHY WAS IT that we listened to air compressor intake noises for years with never a thought of complaint, and then, suddenly, found the noise intolerable?

The writer has speculated about this matter many times during the past five years. Looking back over the different noise troubles that he has been asked to correct, he is obliged to recognize that air compressor intake noises have loomed big. The story of the development of a special intake silencer makes almost as interesting an engineering narrative as the story of the evolution of the silencer for firearms.

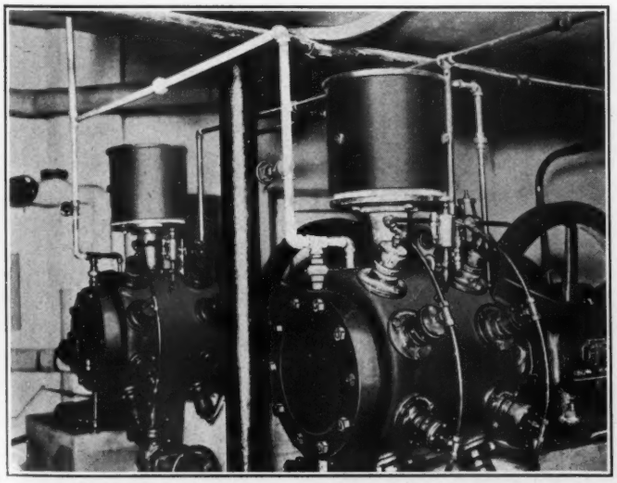
The first time the problem came up was some years ago, when a telephone central station made a complaint that they had bought a Maxim exhaust silencer and could not make it work. The writer happened to be in the vicinity at the time, and he went around to the "central" to look the situation over. He found that the telephone exchange had been built in a residential section of the city, and that everything seemed to have gone all right until the telephone people suddenly began to receive complaints from their neighbors about a "nerve shattering thump or throb" that continued hour after hour, and, frequently, late into the night. The telephone management concluded that the trouble came from the exhaust of a 25-H.P. gas engine, which was used to drive a generator for charging storage batteries. This gas engine exhausted into a cast-iron pot, which was located close to the engine in the basement of the building. The outlet from this pot ran up through the roof, where it discharged into the atmosphere. A Maxim exhaust silencer had been installed in this exhaust line. As the silencer did not overcome the "thump," I was requested to explain why it had not met the situation.

At first, it certainly seemed as though the silencer left much to be desired. There was still a real "thump" or "throb" in the exhaust line despite the perfectly good silencer. Every engineer is confronted at times by these apparently damning evidences of inferiority; but he usually finds that it pays to go behind the scenes and to look into the matter. I asked to be taken to the exhaust outlet so that I might listen to the noise and, incidentally, positively establish the fact that the silencer was allowing it to pass. There was some show of impatience at this request, and it was pointed out that inasmuch as the noise could reach the ears of a deaf man what was the use of going up to the outlet on the roof to hear what was audible out in the street. But as there is "many a slip 'twixt the cup and the lip" in engineering, I insisted, and we went up. It was therefore a surprise to find that on the roof the "throb" could hardly be heard.

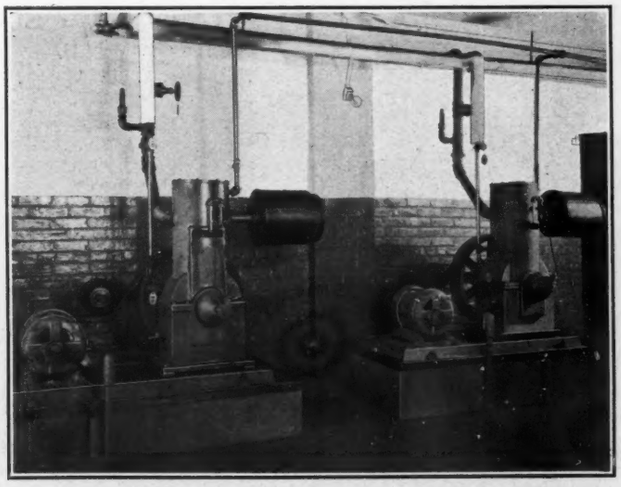
The writer walked up close to the outlet pipe and listened, and to his intense satisfaction and relief he found that the exhaust of the gas engine was all but inaudible. The attention of the telephone people was called to this interesting fact; and some wonder was expressed. It required several minutes before a theory was forthcoming. It came, however, as it always does and this time it was something far-fetched about the noise being inaudible at the pipe outlet and "gathering as it advanced" so that, by the time it reached the neighbors, it was an objectionable noise. The writer knew that no "gathering-as-it-advanced" theory was necessary to account for the noise, and that an investigation would probably make it possible to quickly determine its source.

He asked to be permitted to return to the street. There he listened carefully; and after a moment's "sampling" of the sound his trained ear told him that the noise that was causing the trouble was not like an exhaust noise. Its resonant effect was different, and its basic character was not the same. Then it was decided to listen at the air intake of the gas engine. It must be remembered that the suction of a gas engine is, in most cases, like that of an air compressor.

When the engine room was visited, it was apparent that we had discovered the seat of the trouble. The "nigger in the woodpile" was the "plop" made by the automatic inlet valve of the gas engine when it was suddenly sucked open by the displacement of the piston. The air for the inlet was piped from an outlying alley, probably, if the truth were known, to make things more comfortable for the ears of the engineer. The pipe made a beautiful reson-



A compressor plant located in a hotel. Here the disquieting noise of the suctions of two compressors was hushed by equipping the machines with Maxim silencers.

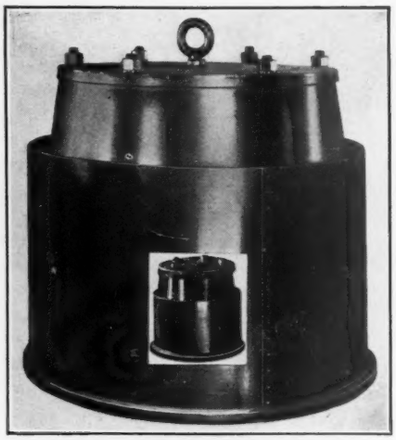


Conversation was made very difficult in a large bank because of the "snoring" of compressors in the basement. A silencer of an improved design effectually subdued the racket.

ating chamber, and the narrow alley acted as a supplemental resonating chamber by picking up the noise as it left the pipe and amplifying it. It was the old mistake of intensifying a noise by every known expedient when the desire was really to reduce it. And the men responsible for this, years ago, had probably conducted the illuminating Fourth-of-July experiment of exploding fire-crackers in a barrel in order to make a bigger noise.

Of course there was no standard intake silencer in existence at that time, so the best that could be done was to improvise one from an exhaust silencer. This was done, and, Lo, the "thump" was gone! Needless to say the telephone people were amazed and delighted; and no expert noise specialist was required to solve the problem. All that was called for was a simple and a direct point of view. Incidentally, the occasion was the first birthday of the intake silencer.

This experience was permitted to lie dormant until a big contractor, who had just finished a large hotel in New York City, appeared and asked if there was any way of getting rid of a troublesome noise from an air compressor located in the basement of the new hotel. It was explained that the compressor "snored" so loud on its suction stroke that it made an intolerable noise which could be heard in the lobby and in the dining-room. The telephone experience was recalled, and this time it was decided to construct a regular intake silencer which could handle the noise properly. The contractor was told that something could probably be done, and that if he would place his order a silencer would be built and shipped which could be easily connected to the intake of the compressor and which would stop the noise and not impede the air flow. One would have thought that he had been granted a favor, for he expressed gratitude and seemed entirely to overlook the fact that he was a buyer and that, according to business conventions, he should have held his head high while we should have expressed appreciation of the privilege of serving him.



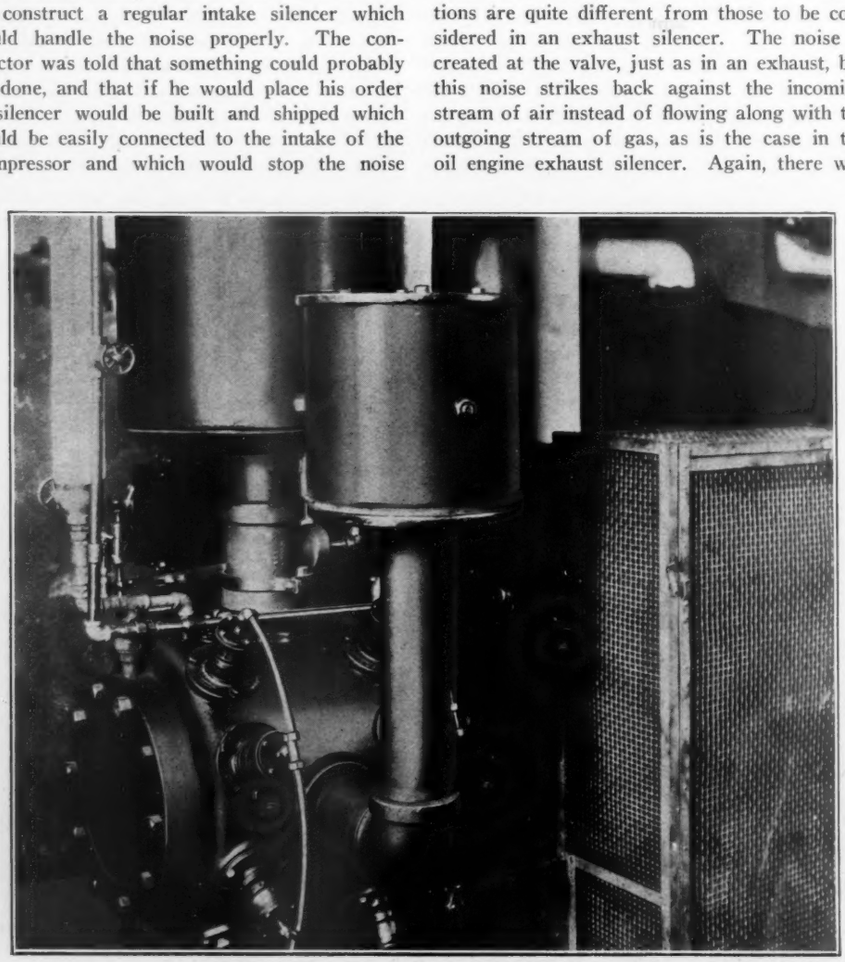
Examples of the latest pattern of Maxim intake silencer. The smaller silencer, in the insert, is for a 1-inch intake and the larger is for a 12-inch intake.

This time a real intake silencer was designed. A moment's thought will show that the conditions are quite different from those to be considered in an exhaust silencer. The noise is created at the valve, just as in an exhaust, but this noise strikes back against the incoming stream of air instead of flowing along with the outgoing stream of gas, as is the case in the oil engine exhaust silencer. Again, there was no heat to consider, as in the exhaust silencer. Back pressure, however, was equally important. The silencer that was finally built, and I wonder if it may not be termed "No. 1 Intake Silencer," is shown as installed in one of our illustrations. This photograph was made after the silencer had been in use for a long time. It worked beautifully; and one of the hotel people told me that "it cut down the noise over 500 per cent." Considering that the noise was 100 per cent., this is seen to be quite a reduction. The hotel management forgot that it had an air compressor about.

This job had hardly been finished when another hotel case appeared. This was also a very desperate one, and there was need for hurry because of the suction noises of two compressors. They were equipped in the same manner as the machine in the New York hotel, and this type of silencer is also pictured here. Not only were the compressors hushed, but an especially complaining hotel operator was likewise hushed.

One more incident completes the story. This was an experience with the builder of a large office structure, in which a very elaborate bank was to occupy the ground floor. This building was the last word in modern equipment. The basements were several stories below street level, and when the question of sewage disposal came up, it was found that this waste matter would have to be elevated in order to make it flow into the city sewer. This was accomplished by compressed air and two large collecting tanks. Everything was lovely until the day of the bank opening, when it was discovered that conversation in the bank could be carried on only with difficulty because of a loud "snoring" noise. The compressors in the basement, while busily engaged in disposing the sewage, snored just the right kind of a snore to cause a very objectionable situation in the bank. In hot haste we were appealed to. We managed to improvise something; and, later, silencers of proper size were installed and the troublesome noise was overcome. This silencer equipment was of an improved design.

The modern intake silencer, as will be noted, is different in shape than the earlier models. The smaller silencer shown in the double picture is for a 1-inch intake and the larger one is for a 12-inch intake. For positive pressure blowers, of which the intake and the discharge are frequently intolerably noisy, the sizes have gone up to sixteen inches. Thus is told the story of the development of the new intake silencer for air compressors, one of the several big brothers of the firearms silencer.



"No. 1 Intake Silencer," which was fitted to an air compressor in a hotel where the noise previously had been very objectionable.

SAND BLAST WITHOUT THE SAND

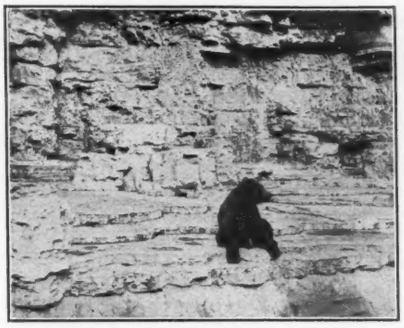
THERE is another name which no longer always fits, though it was right enough in the beginning. In the use of the sand blast the sand is now often conspicuous by its absence, and there is an increasing adoption of metal abrasives, such as shot, grit, and iron crush, and, for some special purposes, materials like coke-breeze and pumice. The Sly Manufacturing Company, Cleveland, is adopting the name "Slyblast" for its product. We would suggest the name "Randblast" as nearer the original.

THE CEMENT GUN EMPLOYED FOR A NOVEL PURPOSE

UTILIZING the cement gun for the construction of artificial rocks, ledges, and crags—environments to which many of our wild animals are accustomed in their native habitats—is an innovation instituted at the largest public park in St. Louis, Mo., where the most unusual bear dens in the world have recently been built. Five large bear dens have been constructed of artificial rock at a total cost of $125,000. They have 75,000 square feet of rock surface; and each den has a frontage of 75 feet on one of the park boulevards. The man-made rock was patterned after impressions and casts of the highlands along the Mississippi River south of St. Louis. More than 3,000 special casts and models were employed in building these dens for bruin and his mates.

The impressions and models, properly reinforced, were set up in the desired positions and then the cement guns were used to spray a mixture of sand and cement over the patterns under a pressure of 40 pounds to the square inch. The rocks were made anywhere from two to ten inches thick, according to the load which they had to support. The sand and cement, in proper proportions, were mixed in the locks of the cement guns, and the concrete was then blown from a rubber hose under high pressure. Six inches back from the mouth of the hose was a supplementary smaller hose which was directly connected to the city water supply. This water completely hydrated the mixture as it passed through the last six inches of the larger hose. The plastic concrete was so forcibly spread over the patterns and the reinforcement that the union with the metal was an intimate one. Concrete rocks made in this way set in 24 hours, and are built at a saving in labor of 50 per cent., and at an economy in material equivalent to 75 per cent. of the cost when the work was done by hand.

Initially, 42 impressions were made of the river bluffs near Herculaneum, Mo. Each impression was an accurate reproduction of a plaster cast that was 30 feet square. These casts were made by coating the surface of the natural rocks with stearin oil and then by applying

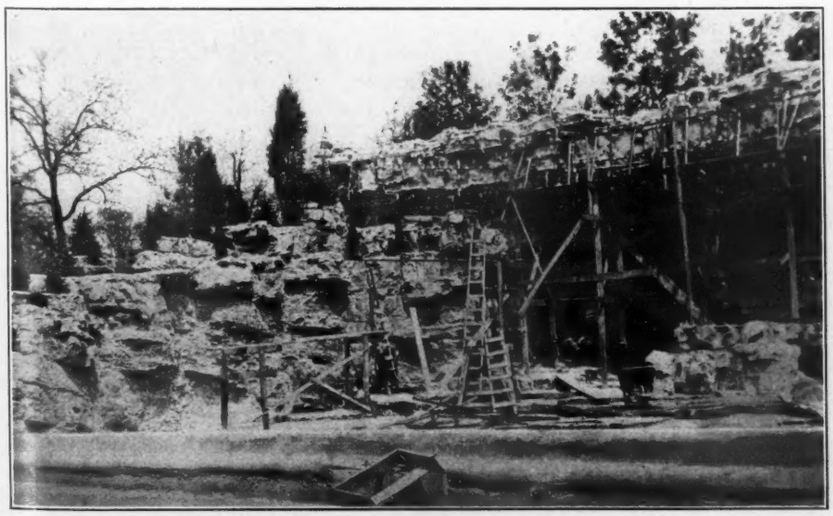


The artificial rocks were colored after completion so as to resemble the natural crags and cliffs abutting nearby upon the Mississippi River.

a covering of molding plaster, half an inch thick, after the area had been fenced in by the necessary plaster frames. Braces and reinforcements were provided so that the casts could be removed after the plaster had set. Next, gelatin impressions were made from the original casts, and these impressions were the basis for the construction of the permanent patterns which were then built and transported to St. Louis. There they formed the background upon which the concrete coating was sprayed.

These novel man-made bear dens are the most unusual pits of their kind. The fact that concrete can be used satisfactorily in such work of a more or less ornamental character introduces a new era in building. The use of the cement gun not only decreases the cost of labor and the amount of materials required, but it facilitates the rapid completion of the work. A crew of five men with one cement gun can build from 2,500 to 3,000 square feet of concrete rock surface of this description in one day when the thickness of the artificial rock is not more than two inches.

It will probably surprise many people to learn that over $700,000,000 were spent in the United States in 1922 on music, musical instruments, and musical education. We lead today in musical activities of all kinds.



Each unit of the bear pits is made up of 15,000 square feet of artificial rock surface. Photograph taken while the unique work was in progress.

COMPRESSED AIR IN CORNISH GRANITE QUARRIES

CORNISH granite has been used for building purposes from time immemorial, and, for at least a century, has been quarried on a commercial basis. It was not until compressed air came to the assistance of the quarryman, however, that the work in the quarries was put on the same mechanical footing as the finishing operations on granite in the stonemason's yard and workshop. This article was written at a time when metalliferous mining in Cornwall was at a low ebb; but in the granite quarries there was and still is much activity, as the market for building stone is good and the services of the monumental stonemason are much in demand.

There are five main granite areas: that in Cornwall and Devonshire; one in Dartmoor, in St. Breward, in Luxullian, and another in Penryn and Penzance. In the Dartmoor district most of the granite is coarse grained and intermixed with quartz, felspar, and white or black mica. A little red granite is found in this region, but most of it is gray. London Bridge is largely constructed of Dartmoor granite; and there is much granite in Blackfriars and other well-known Thames bridges. A gray granite from Gunnislake has shown, under test, a crushing strain of 1,409.6 tons per square foot on 3-inch cubes. The St. Breward granite is very similar to that of Dartmoor, but the Luxullian granite is much more variable.

Relatively primitive methods were used a generation ago in quarrying granite, although the steam drill had by that time come into use for drilling the holes for breaking up the granite blocks to the correct size after blasting. Mr. G. F. Harris, writing on this subject in 1888, in his book called "Granites," stated: "In Cornwall, where blasting is as a rule tolerably easy, the following is the method commonly employed. The first thing to be done is to bore a hole in which the charge is to be placed. This is accomplished by three men, one holding a steel bar with a cutting edge, which, as the hole is bored, is moved round, and the other two striking the bar with hammers. The diameter of the hole varies from three to five inches, and the rate at which it is bored depends on the hardness of the rock and the experience of the workmen. Four feet in nine hours is reckoned good work."

How far steam and compressed air have carried us since the days when three good workmen could produce only a 4-foot hole in nine hours is exemplified by the compressed air drill, which has actually reduced hours to minutes.

Compressed air tools now do the work of boring for blasting, of drilling for splitting up the rock to size, and of chipping and carving the granite into shape in the stone-mason's yard. No building stone has a wider application or a more permanent and pleasing appearance than the various red, gray, and cream-colored rocks of the granite family.

The most important industry of Southern India is the tanning of leather.

What Gold and Silver Mean to Man

By N. S. GREENSFELDER

THE USE of gold and of silver by man began before the period of written history. The color, luster, power of resisting oxidation, and many other fine qualities possessed by these metals, have caused them to be valued from the earliest ages. Allusions to gold and to silver are recorded in the Old Testament. Jewelry and vessels of gold found in Egyptian tombs were made in a period earlier than the government of Joseph. The Greeks were familiar with natural alloys of silver and gold, which they named *electrum*. Rough nuggets of this *electrum* were stamped; and they formed the earliest coins of Lydia.

As centuries passed, gold and silver became more and more firmly established as the standard materials for the manufacture of money, and their use in the arts also became increasingly important. If anyone doubts that these metals are fundamental in the business affairs of the world at the present time, let him consider how long he would continue his present employment without reimbursement with something directly convertible into gold or silver, or how many articles of daily use he is able to secure without payment in the same medium. This simply means that mankind, in the endeavor to give to all labor and the results thereof a fair valuation, has by common consent selected gold and silver as the best materials at hand with which to carry out this idea; and upon them the stability of industry depends.

Gold has been assigned a considerably higher value than silver, and rightly so. It is insoluble in the strongest acids and alkalies. It can be dissolved in a combination of two of the strongest acids known, namely, nitric and hydrochloric, which liberates free chlorine gas, and also in certain cyanide compounds; but in the common uses to which it is put by man it seldom comes in contact with these chemicals. It is exceedingly malleable and ductile; and one grain of pure gold may be beaten into leaves which cover a surface of 56 square inches and are so thin that it would take 282,000 of them to make a pile only an inch thick. A single grain may also be drawn into a wire 500 feet long. This precious metal has a high specific gravity, so that relatively a small amount of it will make a heavy coin.

SINCE the year when Columbus discovered America, gold has been recovered from the earth to the total value of $18,000,000,000; and, similarly in the intervening period, the yield of silver has aggregated $16,500,000,000.

For a long while gold and silver were highly esteemed on account of their glitter and their colorful beauty, which made them desirable for the fashioning of adornments and other ornamental objects. And then came a time when these metals were used as a basis of value in barter and sale.

Today, the monetary systems of all of the principal nations rest upon the value of gold and silver, which is virtually stabilized by the amounts of these metals in existence or in circulation and by the fairly uniform output of the mines in comparison with the expanding needs of industry and commerce.

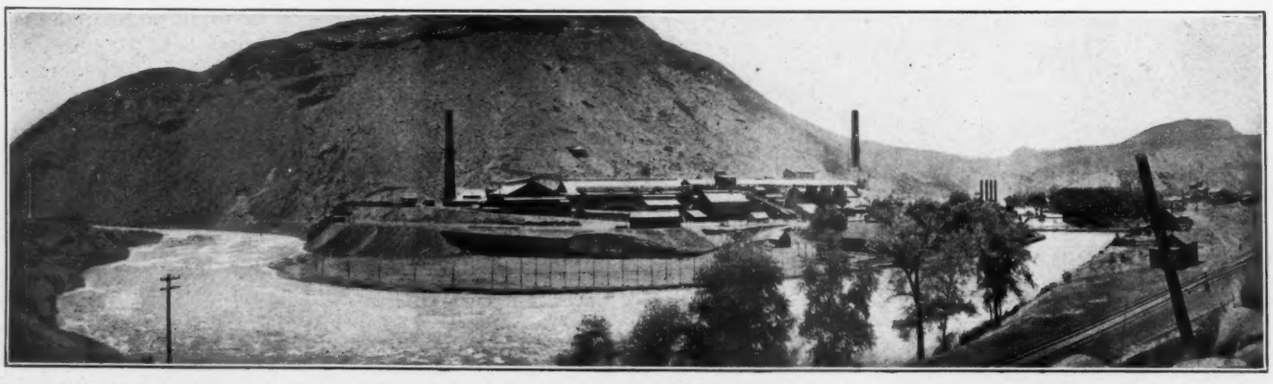
Gold alloys readily with silver and some of the baser metals, and the resultant alloy is of beautiful appearance and even more resistant to ordinary wear than is pure gold. Finally, its limited occurrence in nearly all parts of the world makes it available to the peoples of all nations, but in quantities so small that even without all of the splendid properties mentioned it would be valuable because of the difficulty and the expense of obtaining it.

As might be expected, silver does not equal gold in the respects mentioned, yet it is sufficiently valuable, for all of the same reasons, to be classed as a precious metal. It is soluble in a number of common acids. It is not affected by dry or moist air at ordinary temperatures; but in the presence of sulphur compounds silver will form a sulphide, giving the familiar tarnished surface. It leads all metals as a conductor of electricity and heat; it is second only to gold in malleability and ductility; and it is lighter than gold. It will alloy with gold and some of the baser metals, forming an alloy of fine appearance and of good physical characteristics which recommend it for coinage purposes. It occurs in nearly all places where gold is found, and in many where gold is not present, but usually in larger quantities than gold.

The value of gold has been internationally established as a standard at $20.67 per ounce. Therefore, gold is not subject to market fluctuations. The value of silver, on the other hand, does fluctuate. Since silver was demonetized by the United States in 1873, its market value has varied from about 50 cents to $1.30 per ounce. During the war its value exceeded Bryan's famous proposed ratio of sixteen to one as compared with gold.

In the United States, and in 41 other countries, gold is the sole legal standard of coinage. Silver is the sole legal standard in China, Indo-China, Guatemala, Honduras, and Salvador, while in Belgium, France, Greece, Italy, Persia, and Spain, both gold and silver are legal standards. Silver is used for coinage purposes in many of the countries in which gold is the sole legal standard, but the exchange value of such coins is subject to fluctuation, depending upon the financial conditions existing in such countries, a point which has been brought strongly to our attention during the past few years in connection with European exchange.

On June 30, 1919, the total stock of gold and silver in domestic coin and bullion in the United States mints was valued, according to the figures in the annual report of the Director of the Mint, at approximately $3,500,000,000. A conservative estimate of the world's monetary stock on that date in gold alone was



A general view of the American Smelting & Refining Company's big plant at Durango, Col., where gold and silver are recovered from ores mined in Colorado and Utah.

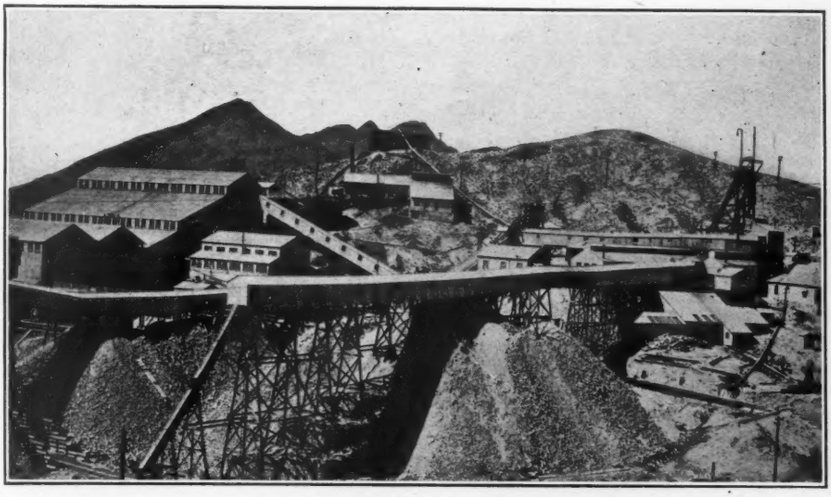
given as about $9,000,000,000, while the paper-money circulation of the world was placed at nearly $20,000,000,000. An estimate of the monetary stock per capita of the world's entire population is $5.14 in gold, $1.07 in silver, and $13.53 in paper. In the United States the per capita monetary stock is much higher—that is about five times the gold figure, seven times the amount of silver, and approximately the same for paper money. We enjoy a higher average than India, for example, whose per capita stock is thirteen cents in gold, 21 cents in silver, and 85 cents in paper money.

Gold and silver are produced in 55 different countries. The most important of these in North America are: the United States and Alaska, Canada, and Mexico, together with the Central American States and the West Indies In South America the most important producers are Peru, Brazil, Chile, Colombia, and Bolivia; in Europe: Russia, Spain, France, and Austria; in Asia: Burma, Japan, China, Korea, and the British and the Dutch East Indies; in Africa: the Transvaal, Cape Colony and Natal, Rhodesia, British West Africa (the Gold Coast), Belgian Congo, and Madagascar; in Australia nearly all of the states are producers, with Western Australia the most important.

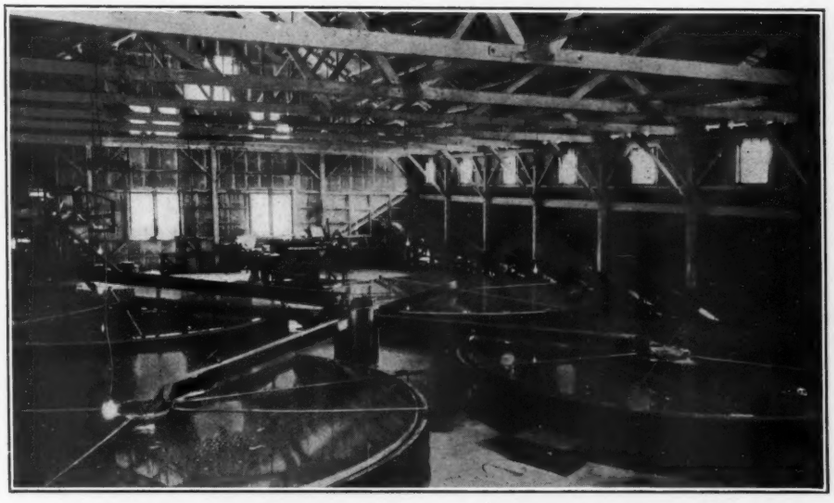
For 1918, and during the last thirty years, the United States was the largest individual silver producer, with Mexico a close second (Mexico was first in 1895 and 1902). The Transvaal led the world in individual gold output, with the United States second in the ratio of eight to three.

On the North American continent there is a great mountain range that runs from Alaska through Canada, the United States, Mexico, Central America, and South America. This, together with a number of shorter parallel ranges, is the great silver-gold belt of the continent. In the United States the western section of the country, from the Rocky Mountains to the Pacific Coast, including Alaska, is the most important producer. In 1918, the states in that region ranked in the following order in gold output: California, Colorado, Alaska, Nevada, South Dakota, Arizona, Utah, Idaho, and New Mexico. In the production of silver, during the same year, they ranked as follows: Montana, Utah, Idaho, Nevada, Colorado, Arizona, California, Alaska, New Mexico, Texas, Michigan, Washington, South Dakota, Oregon, and Tennessee. The quantity of silver mined in the last few states was rather small; and several others yielded even lesser amounts of gold and silver.

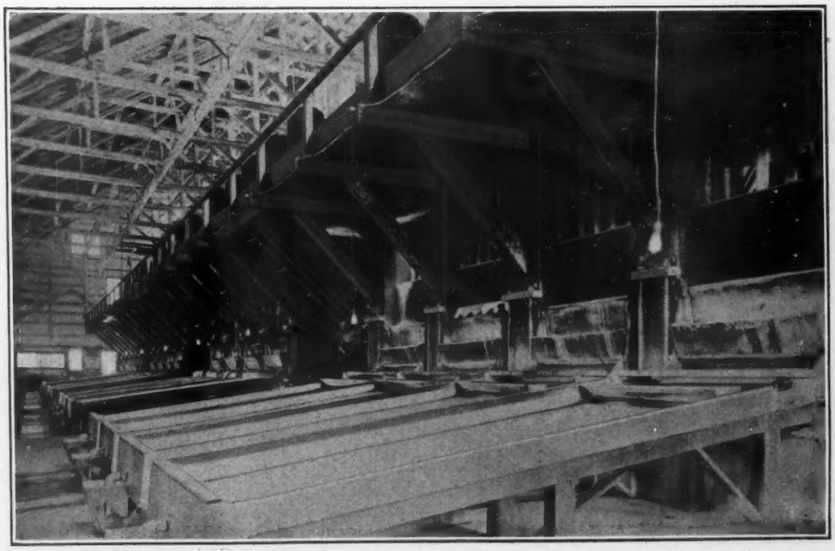
The uses of gold and of silver in the arts are familiar to everyone. Jewelry for personal adornment has been made of these precious metals ever since their discovery by man. Gold leaf is utilized extensively for signs and for other decorative purposes. The exterior of the dome of the capitol building of Colorado is covered with gold leaf made from gold mined in that state, which, ever since the Civil War period, has been a steady and important producer of both gold and silver. The dome of the Congressional Library at Washington is also covered with gold leaf. Many articles of all kinds, ranging



A famous silver mine at Tonopah, Nev. The precious metal is recovered from the ore in a 500-ton cyanide mill.



The cyanide tanks in the concentrating plant of the Empire Mill at Grass Valley, Cal.



The battery floor of the Empire Mill, Grass Valley, Cal. Here the gold is recovered from the ground ore on concentrating tables.

A "Leyner" drifter at work on the 2,000-foot level of No. 4 mine of the Colorado Consolidated at Eureka, Utah.

from collar buttons and tableware to the most delicate instruments, and made of less expensive material, are plated with gold or silver.

A very important use of silver is in the manufacture of photographic films and sensitized papers for which silver compounds, such as silver iodide, bromide, and nitrate, are employed. These are the materials which are sensitive to light, and on which the photographic impression is recorded. In fact, photography is dependent upon this quality of certain silver salts; and the demand for silver for this purpose is rapidly increasing.

California, Alaska, and Colorado are our principal sources of placer gold. The dredging production in 1918 from these localities was about one-sixth of the total output in this country, or about a thirty-seventh of the world's production. In all placer mining operations, gold is separated from the material in which it is found by allowing it to settle to the bottom of sluice boxes, due to its high specific gravity. These sluices often have riffles or obstructions in the bottom which help to catch the finely divided gold. Sometimes quick-silver, with which gold will readily combine to form an amalgam, is also placed in them.

Some of the more important metal mining districts in which gold is the principal product are: The Mother Lode counties of California; Lead, S. D. (home of the great Homestake Mine); Goldfield, Nev.; Cripple Creek district, Col.; Oatman, Ariz., and others, while Park City and the Tintic districts in Utah, Coeur d'Alene district in Idaho; Tonopah, Nev.; Leadville, Telluride, Silverton, Ouray, Creede, and Aspen, Col., yield ores containing large quantities of silver and some gold, usually associated with baser metals like lead and zinc; and the great mines of Montana and Arizona are important gold and silver producers along with the copper, for which they are especially noted.

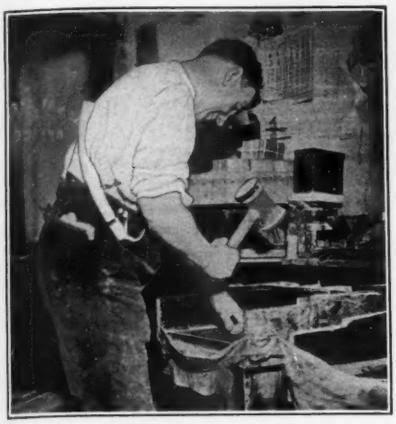
One of the characteristics of gold or silver, in the free or native state, is that it will readily combine with mercury or quicksilver, forming a compound called an amalgam. Recovery in this manner is termed "amalgamation." The ore, after being crushed in various types of mills—such as stamps, rolls, tube or ball mills, chilean mills, etc.—until it will pass through a fine mesh screen, is passed over metal plates coated with mercury. The gold and the silver in the ore unite, or amalgamate, with this mercury and remain on the plate, while the other material is washed away by the action of running water. After a certain time, the amalgam is cleaned from the plates with brushes and the mercury is removed by distillation, leaving the gold and the silver in the retort. If the ore contains nothing but free gold it may be successfully treated by this method alone. If, however, as is usually the case, the gold is chemically combined or so closely associated with silver or other metals that it will not readily amalgamate, then further treatment is necessary for the recovery of the values.

In some cases the ore, after it has been led over amalgamation plates, is conducted to concentration tables, which consist of flat surfaces upon which riffles have been placed, and over which the ore, together with a stream of water, is passed. These tables have imparted to them a reciprocating motion which tends to shake all of the material to one end. The stream of water flows at right angles to the axis of the moving table, and the combination of these two forces, aided by the riffles on the surface of the table, separates the heavier or metallic particles from the lighter rock material, making two products—one termed a concentrate and the other tailings or waste material. These concentrates are often treated by smelting or by a fire reduction process with which most everyone is more or less familiar.

Many gold-silver ores are treated by the cyanide process which is used on account of the fact that gold and silver are soluble in certain cyanide compounds, such as sodium or potassium cyanide. In this process the ore is treated in various stages with solutions of these cyanide salts, which dissolve the gold and the silver. The gold and the silver in solution are filtered from the insoluble material; and later they are precipitated in their metallic state by means of zinc and other reagents. The cyanide process is a very important one and it is used all over the world on ores to which it is adapted.

The flotation process is a concentration process, usually employed preliminary to the smelting of the concentrates so produced, although in some cases, gold and silver flotation concentrates are treated by cyanidation. This process is a paradox. The metallic or heavier constituents of the ore are made to float, and the gangue, or lighter material, sinks to the bottom of the solutions being treated. Without entering too deeply into theory, this action may be explained by stating that the metallic particles in the form of sulphides of the metals, when agitated in solutions containing oil or acid, or both, and usually with the mechanical addition of air which helps to form a froth, will become coated with a film of oil and attached to bubbles of air attracted to this oil film. For this reason the particles become buoyant; rise to the surface in a

An array of "Leyner" sharpeners used in sharpening drills for the mining of gold in South Africa.



Gold beating is one of the vanishing arts. Here we see an expert of this craft hammering a bit of gold into exquisitely thin sheets.

frothy mass; and are removed by mechanical means. The material of a non-metallic nature does not receive this oil film or coating: it is not made buoyant through the medium of air bubbles. Hence, being heavier than the solution, it sinks to the bottom, and is removed.

This process is one of the greatest discoveries in modern ore treatment, as it has proved to be the most economical as well as the most efficient method ever used on a large percentage of ores. It has even been perfected to such an extent that different metals in the same ore can be removed in successive steps by what is known as "selective flotation," and can thus be separated from each other, making concentrates much more suitable for further treatment than had previously been possible. The flotation process is already firmly established everywhere in the treatment of many ores containing copper, lead, zinc, gold, silver, and other metals.

Compressed air plays an important rôle in the production of gold and of silver. Practically every mine yielding ores containing these metals in commercial quantities is equipped with air compressors for operating the necessary pneumatic drills. Compressed air is also used for ventilating portions of such mines, particularly after blasting in poorly ventilated shafts, tunnels, stopes, etc. It is employed for the operation of drill sharpeners, which sharpen the steels used for drilling the rock; at some of the larger mines for running locomotives both underground and on the surface; and for miscellaneous purposes in the mills and reduction plants where the metals are obtained from the ores.

We are apt to think of gold and of silver as precious metals, but without compressed air their cost of production would be much greater, they would be scarcer and, consequently, much higher in price than they are today.

Inside the great Homestake Mine, Lead, S. D., famous for its gold production.

QUENCHING MEDIA

THERE has recently been issued by E. F. Houghton & Company, Philadelphia, manufacturers of oils and leathers for the industries, a rather absorbing pamphlet of 40 pages which reveals how the company's research staff has made it possible to obtain uniformity in the oil hardening of steel. The treatise should be in the hands of every user of steel that may be interested in this matter. The treatment of the subject is uncommonly clear, and, for that reason, all the more understandable and valuable.

As the authors explain, the hardening of steel consists in heating it to a certain temperature, and then quenching it. This temperature, to which the steel must be heated before it can be hardened by quenching, is known as the critical temperature or critical range.

In order to utilize the properties imparted to steel by the addition of carbon, it is necessary to heat the steel through the critical range and then to obtain the hardness desired, for the intended purpose, by regulating the cooling speed.

Steel heated above the critical range has the carbon in solution, and when rapidly cooled this carbon is still retained in solution. The more rapid the rate of cooling the greater the amount of carbon held in solution; and, consequently, the greater the degree of hardness obtained.

To secure maximum hardness, the steel must be quenched, with the utmost rapidity, in a quenching bath which will cool the steel to atmospheric temperature in the shortest possible time. The resulting hardness varies directly with the efficiency of the bath as an abstractor of heat, or its ability to remove the heat from the steel, and is inversely a function of the time required to cool the steel to ordinary temperature; that is, the quicker the steel is cooled the greater its hardness.

The degree of increase in hardness obtained by quenching different grades of steel is governed by the particular composition of the steel, as well as by the rate of cooling. The rate of cooling, in turn, is dependent upon the size of the piece of steel to be hardened and upon the nature of the quenching medium used.

The selection of the right quenching medium is properly determined by the service to which the hardened steel is to be put and also by the character of the material to be hardened. As the rate of cooling of the steel from the critical to the atmospheric temperature controls the degree of hardness, the Houghton Company has given considerable study to the rate of quenching speeds of the various temperatures through which the steel passes during the foregoing treatment.

The same experts have likewise studied these speeds with various temperatures of the quenching bath, the object being to ascertain whether or not the temperature of the quenching medium would influence to any great extent the quenching speed throughout these various ranges of temperature as the steel cools.

After explaining the different effects of such quenching mediums as plain water, brine water, soda-ash water, and oil, the pamphlet emphasizes the superior virtues of special quenching oils. This phase of the subject is admirably covered, and the only apparent short-coming is a failure to deal particularly with the use of No. 2 Soluble Quenching Oil as a medium for the treatment of drill shanks.

COPPER FROM MINE WATER

THE extracting of gold from the waters of the ocean has never approached a financial success: the extraction of copper, however, from mine water is quite a different proposition. The Copper Queen Company is taking 100,000 pounds of copper a year from the water of one of its oldest shafts, each 1,000 gallons yielding 5½ pounds of the metal.

The water, approximating 32,000,000 gallons annually, is pumped through steel pipes, lined with wood, into long troughs, where 78 per cent. of the contained copper is deposited. This is done by running the flow through heaps of old tin cans and scrap iron. The acid eats away the iron, and there is formed an iron sulphate, this again leaching and leaving the copper as a sludge. When dried, this sludge is known as cement copper, assaying 50 per cent. pure metal. During the first six months of 1922 the troughs consumed 155 tons of tin cans and 47 tons of scrap iron.

The output of coins of the Philadelphia mint in 1922 amounted to 14,033,000 pieces. Nearly half of the specie was made for Central and South American countries.

Drill Steel and the Drill Steel Sharpener

PART I

By FRANK BLACKWELL

IT IS DAWNING upon a good many people in various departments of industry that drill steel is something more than just so much metal designed to be worked indifferently to the point of failure or destruction.

Drill steel costs money, and much of it in the course of a year in any activity where a good deal of drilling is done. Whether the outlay for the material be reasonable or exorbitant will largely depend upon the way in which the steel is handled by the blacksmith. The burden of responsibility resting upon the shoulders of the latter is a large one. Again, the way in which he does his work may make all the difference between economy and extravagance.

To the author and to Mr. Gordon Links, who has collaborated in developing the material for the present serial, it has occurred that the procedure followed in the treatment of drill steel in the blacksmith shop of a big iron mining enterprise in Michigan would interest a wide circle of readers and, perhaps, be of practical value to many.

In presenting the subject, the aim has been to put the facts and the daily situation in the plainest possible terms, and this is deemed a sufficient explanation of the style adopted. To save time and space, let us deal at once with the actual conditions in the case of a property having several shafts in operation and with drills kept separately for each shaft. These drills may be loaded on a wagon or sled and hauled into the shop, or, if more convenient, tracks may be run to the shafts and the drills transported on cars. The drills from each shaft are bunched in chains, and on entering the shop they are thus taken from the conveyance.

One of our illustrations, Fig. 1, shows a side of the drill sharpening end of the blacksmith shop. As it happens, the shop has two more sharpening units which are set up to the right beyond the scope of the picture. The drills are brought into the shop through door A on a wagon, which stops at B. The bunches of drills are taken from the wagon with the chain blocks operating on the circular traveling crane, C. The bunches are transferred to the racks, D, one rack for each shaft. The drills with broken shanks are placed on the floor underneath the drills in the racks. Thus they are kept separate for shank repairs. When a bunch is to be sharpened, it is taken by the crane from one of these racks to a sorting rack, which should be at E. The bits are heated in the oil furnace, F, sharpened in the machine, G, reheated for tempering in the oil furnace, H, and cooled in the water cooling tank, I. For shanks, the oil cooling tank J is used.

The crane makes it very convenient to transfer bunches of drills to any part of the shop, and avoids much handling of each individual drill. The car, K, is used in conjunction with the crane, but usually it is near the water tempering tank, I, to hold the drills as they are tempered.

In the Lake Superior iron ore district the economic value of making and of tempering drills correctly has not been fully realized.

Upon leaving the blacksmith shop after sharpening, the drills are handled several times before they are returned for resharpening. After the miner puts a drill into the machine underground, several difficulties may arise as the drilling begins. If the bit was overheated in the blacksmith shop, both the cutting and the reaming edges will either flatten or break off. If the gage of the bit is the least amount larger than the previous bit used in the same hole it must ream its way to the bottom before the hole is drilled deeper, and during this reaming, in hard ground, the outside edges of the bit are worn to such an extent that on reaching the bottom the outside cutting value of the drill has gone.

Drills poorly treated in the blacksmith shop are extremely expensive when we consider the following results:

(a) Inefficient service in drilling the hole;
(b) Much unnecessary handling of drills;
(c) Large number of additional drills required;
(d) Increased wearing away of drills.

Greater economy is effected when sufficient time and attention are given to the drills in the blacksmith shop. Here they should be perfectly heated, sharpened, and tempered. This will result in maximum drilling speed underground, with a minimum number of drills to be handled.

Be suspicious of the quality of bits if a great number per man per day are sharpened. Coming from the mine into the blacksmith shop, the drill bit should not be broken or flattened, but should show the cutting edges worn from efficient work accomplished underground.

For sharpening, the bit is heated in a fuel oil furnace to about 1,600° F. If overheated, the steel is spoiled, for it cannot afterwards be properly tempered. It is therefore advisable to cut off the overheated portion. When in doubt, a pyrometer can be used for the proper temperature. The steel is heated from the end of bit, Fig. 5, to about ½ inch beyond X. The furnace for heating drill bits is shown in Fig. 2. This is made in the shop; does efficient work; and keeps one drill sharpening machine in constant operation. The furnace must be inspected daily and kept clean of scale and any other defects. It must always be kept in perfect repair.

Fig. 2 shows the lower part, F1, of this furnace on the frame, with the upper part, F2, on the floor. The two parts are built separately, and then put together. The minimum amount of the best quality of cement must be used to join the bricks. "Adamant" cement, made by The Denver Fire Clay Company, is highly recommended. The parts F1 and F2 are also joined with this cement. The best grade of fire brick should be used, such as "Aluminite" of 2½x9½x4½ inches. The dimensions of the furnace should be made to correspond to the nearest size of brick used. In Fig. 2, the space between F2

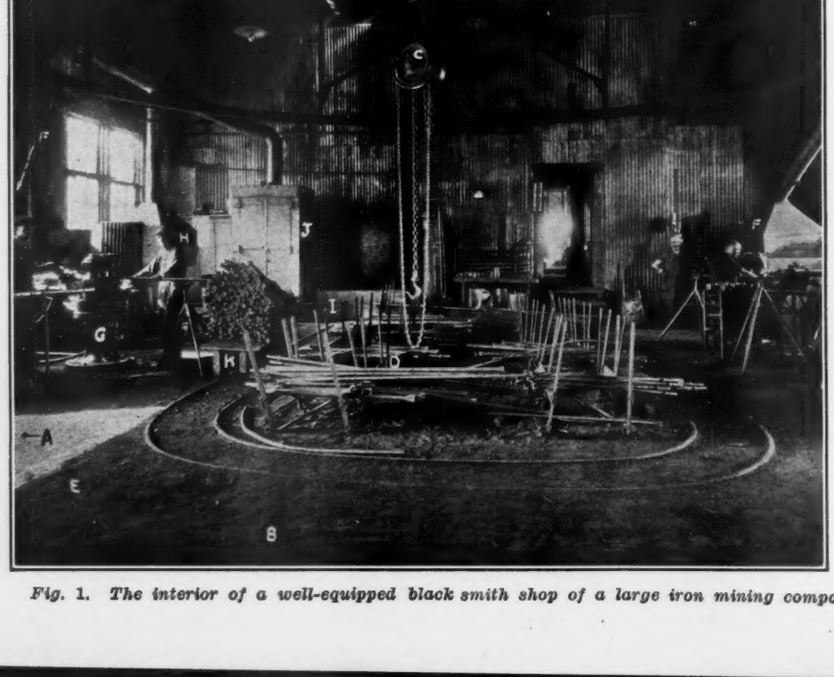


Fig. 1. The interior of a well-equipped black smith shop of a large iron mining company.

and the sheet iron sides should be filled solid. The bottom of the 2-inch hole, F3, through which the oil and air mixture enters the furnace from the burner, is at the same elevation as the bottom of the inside of the furnace. A pyrometer, if used, can be inserted in a hole located at F4.

A very satisfactory low pressure burner for this size of furnace, No. 003, made by The Denver Fire Clay Company, shown at F7 in Fig. 4, is supplied with oil through the pipe F8 and with air through Pipe F9. If, on entering the shop, the air pressure is too high, a reducing valve should be used to deliver air to the furnace at the right pressure. In using such a burner, the heat can be controlled instantly with any proportion of oil and air by turning the valves shown in Fig. 4. The burner makes the mixture of fuel oil and air; and the combustion takes place inside the furnace.

Just below the rectangular hole, where the drills are heated in the furnace, a horizontal air pipe, F5, with perforations on the upper side, blows the hot gases upward into the canopy, F6, from which they are led through a pipe to the outside of the shop. This keeps the shop cool for the workmen, and free from impure air. It also keeps cool that part of the drills not inside the furnace. The pipe, F10, should be vertical and fourteen inches in diameter.

The furnace, as described, will accommodate six 1¼-inch drills, and will keep one drill sharpener busy making perfectly sharpened bits. If for any reason the sharpening must stop, pull the drills from the furnace in order that they may not be kept heated any longer than is absolutely necessary, for the longer the steel remains heated the more it spoils. Do not allow the bits to remain in the sharpening machine when they get below a dark red color. After that point any work done develops cracks in the steel. In addition to this, the dies also are worn. The sharpening can usually be done in one heat. The scale which forms by heating the steel should be removed from the machine and the steel so as not to be worked into the steel.

It is very important to properly sharpen the bit and to gage it to correspond exactly with the length of drill. For every drill, the gaging device, G1 in Fig. 4, as well as the formers, G2, should be used. The formers make the surfaces T S R W, together with W R X, and the thickness RR′ of the wings shown in Fig. 5. These surfaces, except W R X, are finished as explained later. To strengthen the wings of the bit, the corner W to X, is rounded in the formers. Also, W to X is in line with the side of the drill so that the sludge may easily pass from between the wings during the drilling of the hole.

It has been found, through much experience, that a bit made according to the following description is most satisfactory for rapid cutting and for long wearing gages:

In Fig. 5, a 5° taper extends from S to U, a straight line, and must not go beyond point U, which is between RR. The part of the bit at R S R′ U plays a very important part in maintaining the proper diameter of the hole to be drilled by avoiding the drill binding in the hole, which would otherwise cause much delay; breaking of the drill; wear and tear of the drill machine; the need of using additional compressed air; and would also try the patience of the miners. All of this would result in inefficient work. A 14° taper runs from U to V, a straight line. The two sides forming the edge ST are at 90° to each other. If made less than 90° the edges will break on account of insufficient support beneath.

In Fig. 5, all the points on edges RS and SR′ should be the same distance from the axis of the bit and just as sharp as the edge ST. From S to U is 5°, therefore point U is at a less distance from the axis than RS and SR′. Hence

Fig. 2. A partly assembled furnace for the heating of drill bits. The upper part of the furnace is on the ground, at the right.

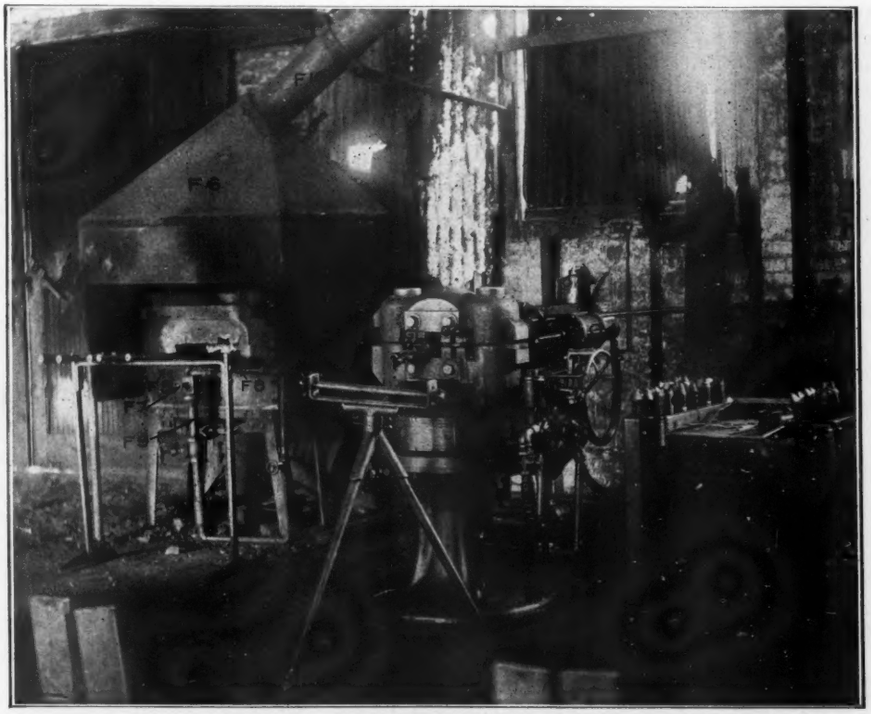
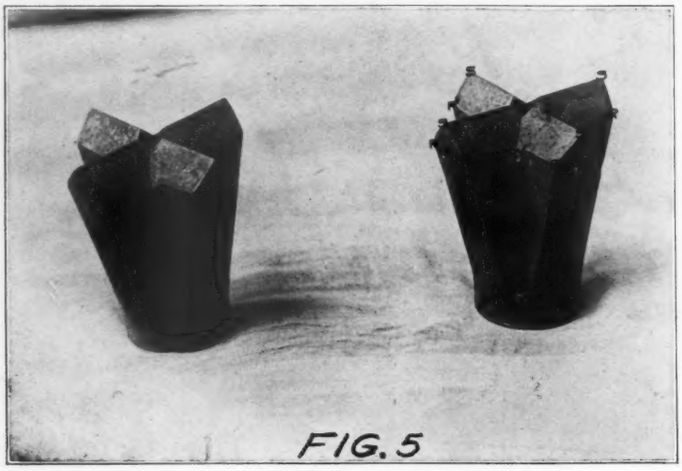


Fig. 4. At the left, an oil-burning furnace for heating drill bits. In the center, a "Leyner" No. 5 sharpener.



Four-point cross-bits. Picture indicates how the various parts should be formed.

RUR′ is flatter than a circle, or elliptical. If U should be the same distance from the axis as RSR′ then, when RSR′ wears the least amount, U will rub on the side of the hole being drilled and so cause the drill to bind; but the drill will clear itself when the reaming edges RSR′ are at the greatest distance from the axis. The surface RSR′ U, as explained, is important, because the drilling speed, in a very great measure, depends upon its proper shape. Also, because of its excellent reaming qualities, a minimum difference can be allowed between the gages of each succeeding drill. This results in a minimum average diameter of holes drilled and, therefore, in less cutting of ground. Let the required size of the bottom of the hole be the deciding factor in the initial gage, and then work toward the larger bits—⅛-inch difference in each succeeding drill. In extremely hard ground, the miner should not use a drill after the gage is worn to the gage of the drill to follow. The gaging block, G1, in Fig. 4, not only gages but also makes this elliptical part of the bit perfect enough for all practical purposes.

When hollow steel is used, the hole at the end of the bit is opened up with a drill steel puncher, G4 in Fig. 4, immediately before sharpening. The puncher may be attached to and made a part of the drill sharpener, or it can be on a separate support.

The dollies G3, Fig. 4, are made ⅛ inch larger in diameter than the required gage of the drill bit. The drill is extended in and beyond (not too far) the 14° sides of the dies, and is upset as well as sharpened by the dollies. The gage and the 5° taper are made in the gaging device, G1, and the 14° taper is forged in the dies by a vertical action of the machine.

Shanks, when required on the drill steel, are heated for forging to about 1600° F., about one inch beyond the point where the lug is to be formed. The lug is formed in the device which goes with the sharpening machine. Open up the hole with the puncher to about one inch beyond the lug. Make the diameter and the length of the shank to fit the drill machine. Two heats are required for this operation. Remove the scale which forms, so that it will not be worked into the steel while forging. This scale will be found in the dies as well as around the drill. It should be blown out of the dies by compressed air, and removed from the heated shank with a file.

Breaking of drills at the lugs will be prevented if the shanking device makes rounded instead of angular corners between both sides of the lug and the side of the drill. The shanks should be of exact length—neither too long nor too short, in order to get the most effective blows from the piston of the drill machine. An emery wheel squares the ends and tapers the corners of the ends of the shanks. The hole in the shank end of the drill steel is countersunk with a twist drill. This prevents breakage of the water tube of the drill machine.

Where many drills must be treated, allow a goodly number of sharpened drills to accumulate, and then temper them all at once in the furnace, H, Fig. 1. In a large drilling operation, have one man and a helper do all the tempering. The work of tempering should be performed by an experienced man; the heating done very carefully; and a uniform heat of 1,440° F. should be kept. The heat should extend about halfway between T and X, Fig. 5. When in doubt, a pyrometer can be used to know the proper temperature. Its location has been given in the description of the furnace.

The light in a shop has much to do in determining the temperature of the steel by color: the darker the shop the brighter seems the heated drill for the same temperature. In some shops a magnetic test of the bit is made to learn the temperature. There is a critical point at which a bit should be tempered: this point being approximately the temperature at which the bit has lost its magnetism. Before tempering remove all scale which may be seen on the bit, otherwise spots covered with scale will not be reached as readily during heating or during the water cooling, and will cause an uneven hardness in the bit.

To temper always plunge in water on a rising and never on a lowering heat. In other words, if the steel is overheated it should not be plunged into the water after the temperature has dropped to that which is required for tempering. It should be cooled either in water or in air and again heated to the required temperature and plunged on a rising heat. The 3-inch opening in the furnace for heating the drills for tempering is made about four inches longer than in the case of the furnace for sharpening in order to accommodate eight or ten 1¼-inch drills. Otherwise both furnaces are the same.

In the tempering process, the bits are cooled in pure, clean, cool water, in the tank, I, Fig. 1. A detail of this tank is shown in Fig. 6. The holes in the perforated plate permit the scale and the dirt to drop through to the bottom of the tank, thus insuring the bits being surrounded with clean water, which is a prerequisite to good tempering. While tempering, a constant stream of water flows through the water pipe, thus continually removing the hot

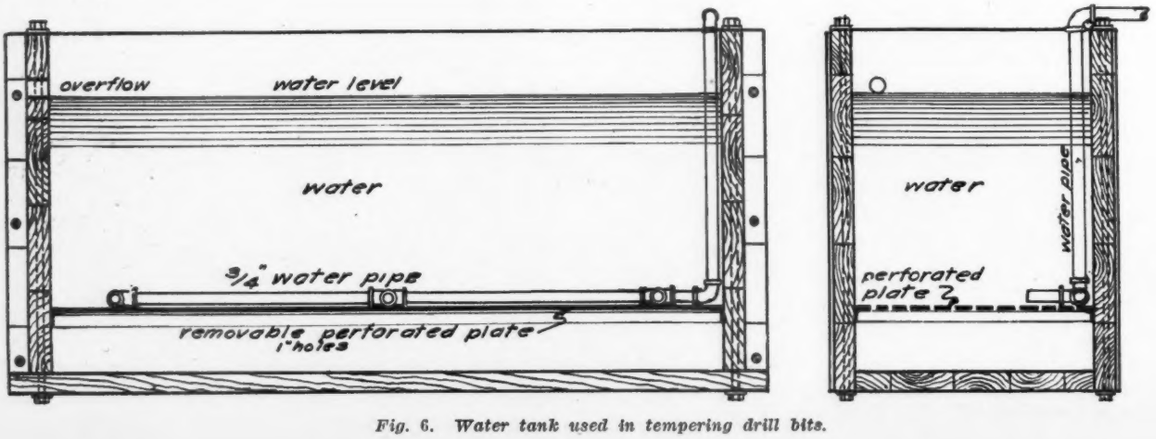


Fig. 6. Water tank used in tempering drill bits.

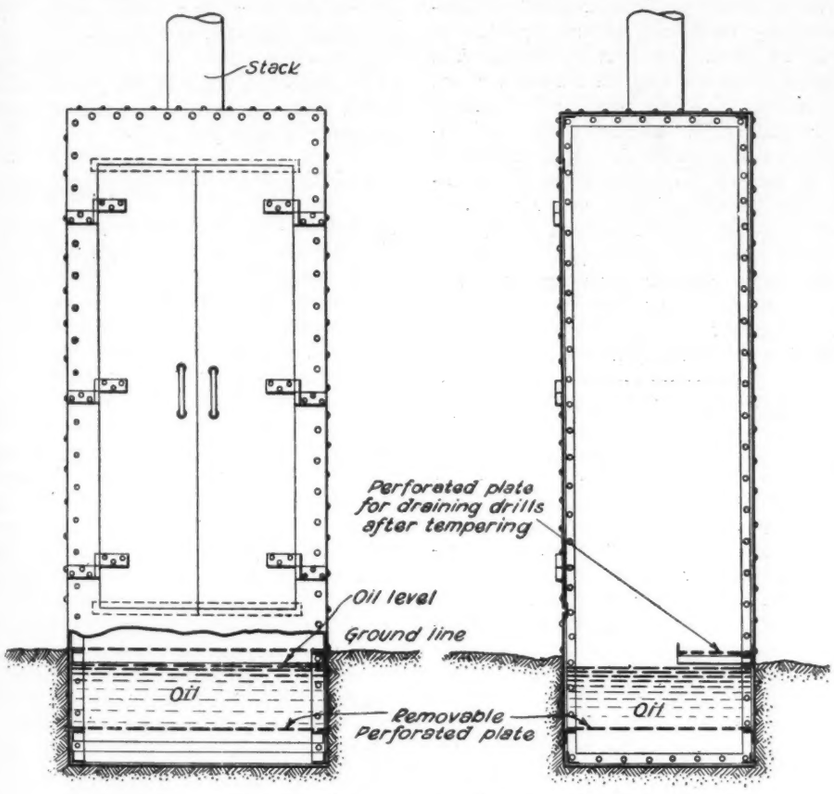


Fig. 7. Oil tank for the tempering of shanks.

water surrounding the bits, and so keeps the water at an even temperature. During warm weather, when the water is warm, the drills are swished in it before they are allowed to stand on the perforated plate. If placed immediately upon this plate when thrust into the water, steam will be produced near the center of the bits and will keep the water from close contact with the bits at that point. Should this occur, soft spots are apt to result. The quicker the cooling the better.

In heating shanks to 1,450°F. for tempering, the heat should be carried as far down the steel as it was carried in the forging heat in order to properly bring the steel back to its normal state. Any heavy scale should be removed before plunging the bits in oil for the same reason as that given in tempering the bits. Temper in a good tempering oil or linseed oil in tank J, Fig. 1. A detail of this tank is shown in Fig. 7. Any scale or dirt falls through the holes in the perforated plate, thus keeping clear oil around the shanks. If many shanks are tempered at once the oil becomes too hot. If necessary, the oil can be kept cool by circulating water through a water-jacket surrounding the oil reservoir.

In addition to the foregoing points which have been brought out let us emphasize a number of general features relating to the subject. The blacksmith should occasionally go underground to see his drills in actual operation in order that he may correct any imperfections.

Thoroughly sound and satisfactory bits cannot be made when the dollies, dies, formers, gaging block, etc., are worn. Insist that these be kept in perfect condition. The drill man should keep his own furnace in repair. He should inspect it daily, and if there is anything wrong with it fix it at once.

It is advisable to use an oversize drill steel rather than to try to get along on a size which is just on the permissible limit for strength, at which many drills are broken and bent. The initial cost will be greater for the larger steel, but in the long run it is much more economical.

Where convenient, it is preferable to purchase the fuel oil in tank lots. The oil is pumped by air pressure from the mine storage tanks into the shop tank, which is sufficiently high to feed the oil by gravity to all the burners in the shop.

We should not be satisfied with "good enough" in the treatment of drills in the blacksmith shop, but should insist that the work be done as perfectly as the best machines can do it. The extra time put on the drills in the shop will, in greater proportion, increase the drilling efficiency underground; decrease the number of drills handled to and from the working faces; decrease the stock of drills; decrease the number of drills to be sharpened; and prevent excessive wear and breakage of the drill machines underground.

(To be continued)

DYNAMITING ROCK

A REPORT from the Chicago headquarters of the Portland Cement Association says that more than 14,000,000 pounds of dynamite were exploded last year in several hundred rock quarries without serious injury to any workman. Charges of from 10,000 to 40,000 pounds are frequent, and sometimes they go up to 80,000 pounds. A pound of dynamite is estimated to displace about five tons of rock.

AUTOMATIC WOOL CLEANING AND DISINFECTING PLANT

THE BRITISH government, as a precaution against anthrax, has installed, at Liverpool, an automatic plant for cleaning and disinfecting imported wool.

The bales, as received, are placed on a traveling platform, which carries them first to a feeding and opening machine. The material is then fed to a machine in which it is subjected to a dilute alkaline solution at 102°F., after which it is squeezed and delivered to another apparatus in which the wool is treated, in two successive baths, by an alkaline soap solution. Passing through rollers, it then enters the actual disinfecting machine, in which the material is put through two baths of 2.3 solution of formaldehyde; next, going again through rollers, it is blown by air into a drying apparatus and discharged into a cooling machine. From there the wool is blown into a charging box of a baling press, and is made up into compact bales.

Handling the material is completely avoided; and the workmen are safeguarded in every possible way. When entering the machines they wear box respirators filled with charcoal. The drying apparatus is provided with a fan to prevent the escape of formaldehyde vapor into the room, while the dust from the raw material is conveyed pneumatically directly to the boiler furnaces.

LOW TEMPERATURE RECORD

A PAPER on *The Generation and Utilization of Cold* was read recently, at a joint meeting of the Faraday Society and the British Cold Storage and Ice Association, by Dr. H. K. Omnes. Through the successive temperature ranges of liquid air and liquid hydrogen, the lowest temperatures yet known have been attained by the use of liquid helium.

This liquid, at normal pressure, has a boiling point of —268.83°C. (Absolute zero, it will be remembered, is —273.1°C.) Attempts to solidify the liquid have been unsuccessful. In the course of the experiments the lowest temperature ever reached was produced: 0.82 absolute, or —272.28°C. With the vacuum apparatus employed a suction pressure of 0.005 mm. was reached.

GROWTH OF CEMENT INDUSTRY

THE following figures will make it plain just how the cement industry has grown in the last two decades and what it means commercially today. In 1902, there were shipped a matter of 17,000,000 barrels of cement, and in 1922 the figure amounted to six and a half times that quantity, or 110,000,000 barrels, despite a generally restricted building program.

In the field in which the cement business was most successful, the construction of concrete roads and pavements, the figures are even more suggestive. In 1914, there were used 5,000,000 barrels for this purpose, and in 1921 about 22,000,000 barrels were required. In short, the demand for cement for road building alone increased 440 per cent. within a span of eight years.

There is one telephone for every twelve persons in Denmark.

Compressed Air Magazine

—*Founded* 1896—

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EDITORIALS

THE SUBMARINE DRILL IN IMPORTANT CHANNEL WORK

THE WORK of the rock drill in clearing open cuts and in speeding up mining and underground excavations has long since ceased to be a source of wonderment to the people at large. There are relatively few, however, that realize what the rock drill is doing under water in deepening channels for vessels of heavy draft.

As a wartime measure, the Government decided to blast a wider and a deeper fairway in the East River, in the harbor of New York, so that the largest of the nation's battle craft could pass in and out under all conditions of the tide in approaching and in leaving the Navy Yard in Brooklyn—the most important base on the Atlantic coast for the fighting fleet.

The latest of our superdreadnoughts have a normal displacement of 33,000 tons, and when loaded for sea they draw slightly more than 31 feet of water. In case of injury, leading to the flooding of some of their compartments, this draft would undoubtedly be measurably increased. Therefore, the Federal authorities determined to alter the existing situation by removing a considerable portion of what is known as Diamond Reef so as to provide a channel at least 40 feet deep at mean low water between the lower tip of Manhattan and the northern end of Governors Island.

At the present time, the task in hand involves the completion of the removal of subaqueous rock throughout an area 150 feet in width and about 1,200 feet in length. The entire task will embrace the blasting out and the dredging of 60,000 cubic yards of rock; and to date the job is approximately half finished. Not only are the drill holes of unusual size, but the drill barges engaged in these operations are exceptional in a number of particulars. Further, the charging and the blasting are carried out in a way that is unlike that pursued in the open air or underground. The methods adopted show how resourceful the modern engineer is in meeting conditions, no matter how difficult they may be.

SQUEEZING THE WASTE OUT OF INDUSTRY

UNDER THE foregoing title the Director of the United States Bureau of Standards summed up the outstanding activities of his department in submitting his annual report covering the fiscal year ending June 30, 1922.

Having recognized for many years that the elimination of waste, like all fundamental industrial questions, depends upon correct scientific and technical data, the Bureau set itself to act as a clearing house for information along these lines. Its staff has assisted in preparing codes and specifications; and it has conducted a great number of investigations in its laboratories, all of them with the object of obviating unnecessary waste in American industries.

It would hardly do to try to enumerate the whole list of these investigations, but a few of them may be mentioned to give a hint of what has been done and what the service rendered represents for the common good. For instance, a complete study of automobile engine performance, both in the laboratory and in cars on the road, is being carried out in an effort to increase the efficiency of internal combustion motors. If the Bureau, through this work, can assist in lowering the gasoline consumption of automobiles only 10 per cent. for a given mileage, it will represent a saving to the country of something like $100,000,000 a year.

Again, large sums are lost each year through the corrosion of underground pipes, conduits, and metal structures. Part of this is the result of electrolytic action, while another part is caused by conditions of the soil. The Bureau has mapped out an extensive program of study relating to this subject, and, if possible, hopes to arrive at means by which this waste can be prevented.

Further, most appliances used for heating by gas are operated at very low efficiency, with a subsequent waste of gas and also with very bad effects on persons working in rooms where this occurs, because imperfect combustion means the generation of carbon monoxide, which is extremely poisonous. The Bureau has thoroughly investigated the subject of improving both natural and artificial gas burners, and, as a result, it has issued recommendations which will notably reduce gas consumption and lessen the danger to the health of the users.

Finally, the Bureau has done valuable work in its researches in the construction of buildings, and has established conclusively that more material than is really necessary is often used for a wall, a column, or a floor slab. Here is a matter that touches a branch of industry that is of tremendous scope; and any economies in this field must inevitably represent savings of great monetary value.

ANOTHER CITY OF BRIDGES

ACCORDING TO plans approved and under advisement, San Francisco and the neighboring towns will vie ere long with the City of Greater New York in the number of big bridges which are to span adjacent bodies of water and thus to speed up and to facilitate intercommunication by vehicular traffic.

One of these structures is to have a length of 11,500 feet and, with an associate 3,500-foot subway, is to link up San Francisco with Alameda, on the eastern side of the bay. A second undertaking contemplates bridging Carquinez Straits, thus bringing within direct touch Benicia on the north and Port Costa on the south of this waterway. It is said that the United States Army Engineers have virtually given their approval to the project, which will call for the erection of a structure having a total length of 3,100 feet. The central span will be 1,500 feet long and have a clearance of 135 feet above high water. The two towers, flanking each side of the channel, will be 300 feet high; and as these towers will rest on piers carried down to rock 90 feet below the level of the tide it will be necessary to employ pneumatic caissons in securing the needful footing.

Probably the most ambitious of all of these schemes is that for a bridge to be thrown across the Golden Gate. Nothing approaching the engineering daring of this project has hitherto been essayed, and yet the plans are said to be soundly based upon other big bridges which have been constructed with eminent success. The central span will have a reach of fully 4,000 feet; and it is reported that the design is the outcome of the joint labors of J. B. STRAUSS of Chicago and M. M. O'SHAUGHNESSY, City Engineer of San Francisco. If the Golden Gate span be built then all other suspension bridges will appear insignificant by comparison.

OUR SALES OF INDUSTRIAL MACHINERY ABROAD

ABOUT three weeks ago, WALTER H. RASTALL, in Commerce Reports, announced that the situation at the turn of the year carried with it brilliant prospects for increased American business abroad in the disposition of industrial machinery.

This recognized authority went on to say that before the war Germany supplied 44 per cent. of the machinery absorbed in the international trade of the world, the United Kingdom about 29 per cent., and the United States something like 21 per cent., but that since 1914 the bases of this trade have radically changed.

Reports from the Netherlands, Belgium, and Austria indicate that it is difficult now to do business with Germany; and the German handicap will obviously be greater in Asia, Latin America, and other important regions. Amer-

icans ought to obtain and to hold a substantial share of the 44 per cent. that Germany once controlled.

British manufacturers are also encountering serious difficulties. A great many of the machinery plants of the United Kingdom are not really equipped for their present products. Moreover, they have lost many of their best markets, and their business organization has been disturbed in order to develop new ones.

The foreign demand for American machinery and American expert service is unprecedented. Our prestige as engineers and machinery builders has been greatly advanced. In 1921, China bought $18,184,978 worth of American machinery, as compared with $260,431 in 1913, while Egypt purchased $1,733,625 against $69,753 in the prewar year.

Press reports from Europe have created a certain degree of unwarranted pessimism concerning the possibilities of foreign business. But conditions in Asia, Latin America, Australasia, etc., are entirely different. There the exchange situation is much less troublesome and trade is expanding rapidly, especially along the lines of engineering equipment—conditions justifying careful, constructive sales work in most of these countries.

In the last four years, American manufacturers have shipped more than $242,000,000 worth of machinery to Asia, a volume greater than would have been shipped there in four decades at the prewar rate. The employment of this equipment is raising the standard of living in Asiatic countries; is cheapening the cost and increasing the output of many of their standard products; is providing an opportunity to tap natural resources; and is also serving as an educational medium. In short, it is modernizing Asia. In 1913, Asia absorbed 6.8 per cent. of the industrial machinery exported from the United States, while by 1921 the figure had become 26.1 per cent.

The possibilities for sales abroad are now the best they have ever been; and good, constructive sales work in those territories where our markets are expanding will probably yield more satisfactory results than have ever been realized before.

THINKING

THE AVERAGE man works about eight hours a day, or is supposed to. The balance of the time is divided equally, so the theory runs, between recreation and sleep.

Of the sixteen waking hours how many are devoted to thinking? Psychologists tell us that a tenth of the period is a liberal allowance, and from that on down. Only a little more than an hour and a half out of the twenty-four occupied in thinking!

Thinking is one of the most difficult and tiring of occupations. Were this not so it is probable that we might spend more time at it. To prove this, try to concentrate your mind on the book you have just read; on the lecture you have recently listened to; on the interview you have had on an important business matter. Try to remember and to recount to yourself, item by item, just as much as you can of the thing you read or listened to. It will tire you out. Unless you have trained yourself to the task, your mind will wander—you will lose the thread.

Psychologists recommend the cultivation of thinking habits: they advocate less reading and more thinking about what has been read, heard, and seen.

"As we do this well or ill," says JOHN STUART MILL, "so will we discharge well or ill the duties of our several callings."

A MOVE FOR GOOD ROADS IN CHINA

THE AUTOMOTIVE vehicle is compelling a transformation of the highways of the Orient just as it is forcing betterment elsewhere the world over.

It is reported that merchants of Shasi, in Hupeh Province, China, have subscribed $100,000 for the inauguration of a motor-car service between Siangyang and Shasi. The Good Roads Movement Society of Shanghai will be consulted regarding the construction of the road, the engagement of an engineer for the work, and the purchase of automobiles. In furtherance of this scheme, the Hupeh provincial authorities have drawn up a list of regulations governing subscriptions to the fund, and plan to invite additions until the amount reaches $1,000,000.

With the ripe experience gained by American road builders in latter years there would seem to be an inviting field of service open to some of them in the Far East in carrying out the project mentioned and in advancing other undertakings of a similar nature. In the execution of tasks of this sort and in maintaining the highways in proper repair there should also be a chance to utilize profitably many of the tools which have been developed in the United States for this kind of work.

CURBING THE COLORADO

A STEP toward putting a rein upon the impetuous Colorado has been taken recently. As the result of a conference between HERBERT HOOVER, Secretary of the United States Department of Commerce, and representatives of the several states directly concerned, an agreement has been signed covering the prospective development of the Colorado River.

Besides providing for the establishment of a number of great hydro-electric power stations, arrangements are contemplated which will permit the waters of the river to be used in mining undertakings and in the irrigation of vast areas which are now unfruitful but susceptible of being made extremely productive.

The immediate plan provides for the construction of a towering dam athwart Boulder Canyon, at a point about 460 miles up the Colorado above tidewater. This dam will have a height of 600 feet above the normal surface of the stream and form a bond between the adjacent precipitous slopes of the States of Nevada and Arizona. From an engineering point of view the proposed barrier will be a stupendous task because of the violent floods which, from time to time, crowd the valley and rush with well-nigh irresistible force toward the distant Gulf of California. The dam must rise from the bed rock underlying the water course; and this foundation must be secured while halting in the least practicable degree the onward sweep of the river. Not until the dam has reached its climax can the stream be seriously impeded.

By impounding the waters of the Colorado during periods of flood or stimulated flow, it will be possible to form an immense reservoir reaching up stream for a long distance; and the amount of water so held in reserve will be many times greater than that now confined within the area of any kindred project elsewhere. This reservoir will serve the year through to insure ample motive power for the driving of numerous big hydro-electric turbines and to satisfy, among other things, the thirst of that vast agricultural and horticultural hothouse, the Imperial Valley of California. This region, a veritable desert 23 years ago, now supports a population of 75,000 and yields annually crops worth quite $100,000,000.

Not only the Imperial Valley but other lowlands in this general region are menaced whenever the Colorado goes on the rampage. Millions of dollars have been spent in the rearing of levees and other protective works—not always with complete success. The construction of the Boulder Canyon Dam will obviate further outlays of this uncertain sort and lead to other benefits too numerous to mention here.

THE BURDEN OF THE TARIFF

SOME interesting comparisons have been made by Prof. IRVING FISHER, of Yale, between the Fordney and the Payne-Aldrich tariffs. According to his figures, the Fordney rates, on the 288 items where comparison can be made, are 23 per cent. higher than the Payne-Aldrich rates.

Attention is called to the fact that even this 23 per cent. increase over the highest previous tariff rates takes no account of the provision in the Fordney bill which permits the President to raise rates still further by substituting American for foreign valuations, nor does it take into account the increases which are usually hidden in reclassifications.

Professor FISHER has also discovered that the rates in the Fordney bill are 59 per cent. higher than those of the Underwood tariff.

AN INDUSTRIAL RECORD

AT THE outing of employees of a firm of spring balance manufacturers, West Bromlich, England, attention was called to a unique record of service. No fewer than 180 persons now in the service of the concern have been over 30 years in its employ, and, in addition, 25 former employees are availing themselves of the firm's old-age pension. The outing was led by a man who has served the company 77 years, beginning at the age of nine. Two have over 60 years to their credit, and twenty have been with the firm over half a century.

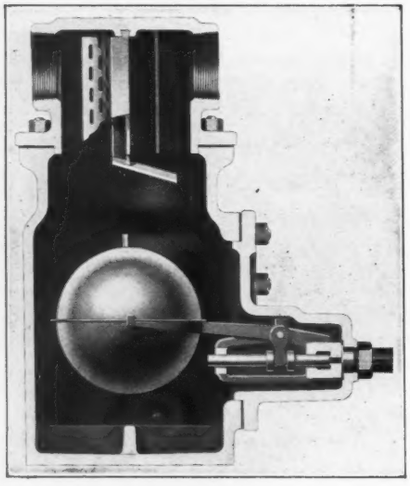
The question is, can we, in the United States, show anything to even compare with such a record?

"DRIAIR" SUPPLEMENTS THE AFTERCOOLER

AN INGENIOUS apparatus, called the "DriAir," has been devised to supplement aftercoolers in compressed air lines for the purpose of still further reducing the moisture content of the air; and it is claimed for the attachment that tests show that it is capable of performing at an efficiency of 99.5 per cent.

It is a well-known fact that when water accumulates in the piping of a compressed air system that it may slow down the operation of pneumatic tools, may freeze in the exhaust, may wash out lubricating oil and thus promote rapid wear and rusting of parts, etc. Indeed, if the water collect in sufficient quantity in piping, when finally picked up and carried onward by the air impulse, it may act as a water-hammer and loosen scale, rust, or dirt from inside the pipes and convey these gritty materials to operating equipment and do them harm.

An efficient aftercooler will extract from the air coming from a compressor substantially 80 per cent. of the moisture content. For instance, if the total weight of moisture taken

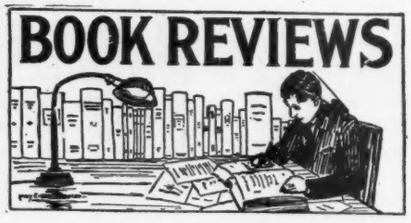


Courtesy, New Jersey Meter Company.

Cross-section of the "DriAir" attachment designed to supplement the aftercooler in freeing compressed air of moisture. The globular float is equipped with a self-bailing feature.

in with the air by a compressor in the course of eight hours amounts to 600 pounds, then a good aftercooler will precipitate and collect 480 pounds of water, and 120 pounds of moisture will go forward through the lines in the form of vapor. It is with the remaining 120 pounds of moisture that the "DriAir" is designed to deal.

The "DriAir" is automatic in its discharge action, and one of its distinctive features as a trap is an ingenious, self-bailing and non-collapsible copper float. The float is designed to receive the same pressure inside and out; and whenever there is a momentary, slight drop in the external pressure, the pressure of the air within the sphere serves to expel by way of an equalizing tube any water that may have gathered within the float.



THE CONTROL OF QUALITY IN MANUFACTURING, by G. S. Radford, consulting engineer, of 404 pages, with illustrations. Published by The Ronald Press Company, New York. Price $5.

THE PURPOSE of this book is to offer a new approach to the problem of economic production, and it deals with a subject of widespread concern. It is commonly, but erroneously believed that quality is necessarily synonymous with high cost of manufacture. To a considerable extent this understanding is the consequence of that advertising policy which lays stress upon the claim quality has to a worth-while price. It is undoubtedly true that cheapness to the purchaser may, in the end, entail disproportionate expense. On the other hand, a high price to the ultimate consumer, when quality is assured, does not necessarily mean that the commodity is costly to produce.

As Mr. Radford makes plain, very high-grade quality products are often high priced, but lower grade and less expensive articles also possess their own quality standards, and, be these what they may, there may be serious losses incident to ill-considered or improper factory procedure. The self-deceiving notion that the ultimate consumer foots the bill explains why some men fail and others succeed in identical lines of endeavor. The wise manufacturer knows that he can outstrip his competitor best by controlling quality throughout every stage of production and thus guard against waste and losses while turning out a superior and, withal, cheaper commodity.

The book is the result of an intensive study of the subject in hand; and the aim of the author has been to show that the control of quality is the correct starting point for economy. As he puts it, "If quality is under positive and continuous control, increase of output follows as a by-product advantage."

MAKING YOUR CAMERA PAY, by Frederick C. Davis. A book of 96 pages, published by Robert M. McBride & Company, New York. Price $1.

ALL TOO many cameras are owned by people who find the instruments a source of expense rather than material profit, even if they do obtain some measure of pleasure from its possession. Mr. Davis has set himself the task of dealing with the camera not primarily as an instrument for taking pictures but as a means by which money can be made through the taking of the right photographs and marketing them properly. He discloses that editors are eager to get the best photographs obtainable without thought to whether they are the result of the work of amateurs or professional photographers, and he tells us that professional photographers do not produce one-third of the photographs used. Mr. Davis' little book is authoritative.

MECHANICAL LABORATORY METHODS by Julian C. Smallwood, M.E., Associate Professor of Mechanical Engineering, Johns Hopkins University. This is the third edition of the work, is of 423 pages, and contains 112 illustrations. Published by D. Van Nostrand Company, New York. Prince $3.50.

THE PRESENT edition of this well-known work has been deemed necessary largely on account of the latest standards of performance now being developed by the Power Test Committees of the American Society of Mechanical Engineers. Numerous changes have been made in text and in tables wherever such alterations have been considered advisable or likely to prove of service. The section on Combustion has been entirely rewritten in the desire to make easier of understanding this admittedly difficult subject.

THE SCIENCE OF PURCHASING, by Helen Hysell. Of 261 pages, published by D. Appleton & Company, New York. Price $2.50.

ACCORDING to the introduction written by J. George Frederick, President of the Business Bourse, New York, the present volume is the first recognition of the fact that the science of purchasing has also been keeping pace with the science of selling. As he puts it: "The modern purchasing agent is a more important man by far than he was in older days when purchasing agents were likely to be more of the nature of 'rubber stamps,' or 'buffers,' or were bargainers for an extra penny of advantage. A purchasing agent of the modern breed is a creative thinker and planner and a student of many elements of business."

The book should have a place in the working library of business houses and on the shelves of all students of purchasing.

THE HYDRAULIC PRINCIPLES GOVERNING RIVER AND HARBOR CONSTRUCTION, by Curtis McD. Townsend, Colonel, United States Army (retired), of 189 pages, and published by The MacMillan Company, New York. Price $2.60.

AT THE very start of his book, Colonel Townsend states that during his professional career he has prepared numerous projects and has answered many criticisms of the methods employed in the improvement of rivers and harbors. His experience has revealed to him that there is a commendable interest among the American people in the subject of the improvement of the nation's waterways, and, at the same time, a very notable ignorance of the fundamental principles governing the flow of water in natural channels.

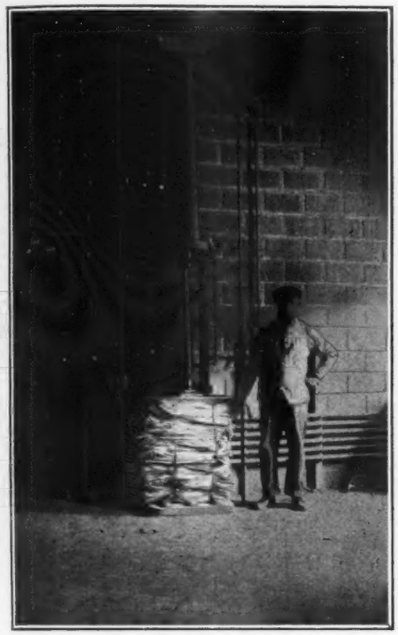
As he expresses it: "The ordinary textbook on hydraulics treats principally of the flow of water in pipes and conduits, and the ordinary engineer is apt to consider a river as merely a large conduit governed by the same laws, ignoring the change in conditions arising from the fact that the walls of a pipe are not affected by the velocity of flow through it, while the channels of a silt-bearing stream expand or contract with every change in the volume of discharge."

The author has developed his subject in an informative and an interesting manner, and the book should be of value and guidance to engineers and to other persons identified with the betterment of rivers and harbors.

BALING EMPTY BAGS WITH A COMPRESSED AIR RAM

AT THE bag house of the Sandusky Portland Cement Company, Dixon, Ill., a new use has been found for the pneumatic ram. The ram is utilized for the baling of empty cement sacks. The empty sacks are received in this department and are first put through a large, revolving cage, which cleans out all of the dust. This dust is reclaimed, and is sent back to the warehouse for loading.

After the cleaning process the bags are taken out of the cage and put on a sorting table,



Baling empty cement bags by the pneumatic ram.

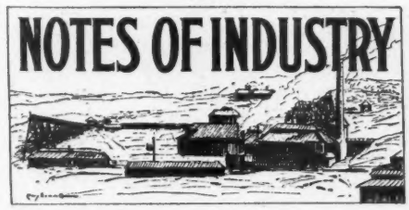
where all of the foreign bags are removed and the torn bags are sent to the repair department. The good bags are piled on a table in lots of 100, which are trucked away to a platform under the compressed air ram. With everything in readiness, the operator merely pulls a lever, and the ram presses the bags into a tight bale. Each lot of bags is then tied and taken to the bag storage department.

This method of baling is simple and efficient, and does away with a lot of unnecessary labor. Two pneumatic rams are used for the purpose at the plant of the Sandusky Portland Cement Company.

AUTOMOBILE AND RAILROAD PASSENGER SERVICE

IT IS a simple and an easy matter to figure out that the automobiles in use carry more passengers than the railroads. There are 55,250 railroad passenger coaches in service, with a seating capacity of 2,270,000 passengers. Based on records for the last five years, there should be 47,000,000,000 passenger-miles to the credit of the railroads in 1922. The average number of passengers per automobile is two, and the average mileage 6,000, with 9,500,000 autos in use. On this basis, the autos must be credited with 114,000,000,000 passenger-miles in 1922.

NOTES OF INDUSTRY



The Sheffield research metallurgists have discovered another process, so we are advised by the United States Bureau of Foreign and Domestic Commerce, by which they can make metal articles stainless. This is accomplished by depositing a film of chromium upon the metal by the same method as that employed in electroplating. It is thus possible to make a knife, for instance, of ordinary steel stainless without the use of expensive stainless steel.

The city of Helsingfors, Finland, has purchased a new ice-breaker, which is expected to keep the harbor open a few weeks later in the fall and to allow shipping to be resumed earlier in the spring. Should the season be a mild one, it may even make it possible to keep the port open the winter through.

Production figures for twelve months, ending October 31, 1922, show that there were manufactured in the United States three pairs of shoes for each one of its 110,000,000 inhabitants.

Italian and French engineers are planning to run a 2-bore tunnel through Mont Blanc for the purpose of shortening the trip by rail between Paris and Milan. This tunnel, which will be a direct competitor of the Simplon Tunnel, is to be ready for traffic within five years. It is to be about nine miles long and, according to news reports, seven short tunnels on the French side and six on the Italian side are to lead up to the main passageways.

Germany leads all countries in Europe in the production of tobacco, with an estimated crop in 1922 of 77,140,000 pounds.

The original well in the Norman oil field of the Mackenzie River area in northern Canada, which had become filled with debris, was cleaned out and deepened during the summer of 1922 and is now producing 60 to 70 barrels a day. This would seem to verify the contention of a Pennsylvania operator who insists that old wells can be "rejuvenated," and has done so.

The largest and the most modern ice plant in the Far East was recently erected on the island of Hikoshima, between the southern point of Japan and the island of Kyushu. The refrigerating machinery was furnished by the American firm of Frick & Company, the electrical plant was supplied by Japanese firms; and the turbo-generator was provided by a Swedish firm. The plant was established for the purpose of supplying native fishing boats with cracked ice.

According to the latest official statistics of the government mining engineer, there were 495 mechanical coal cutters in use in South Africa in 1921. Of this number 50 were operated electrically while 90 per cent., or 445, were actuated by compressed air.

The protracted summers in Italy are conducive to a large consumption of ice, and for some years artificial ice has been made in that country. However, the supply is not equal to the demand. In the city of Palermo, with its 470,000 inhabitants, there are but three ice-making plants, having a maximum capacity of 170 tons a day or a little less than three-quarters of a pound per capita. Looking at it from the American standpoint, this quantity is hardly enough to furnish ice water for drinking purposes.

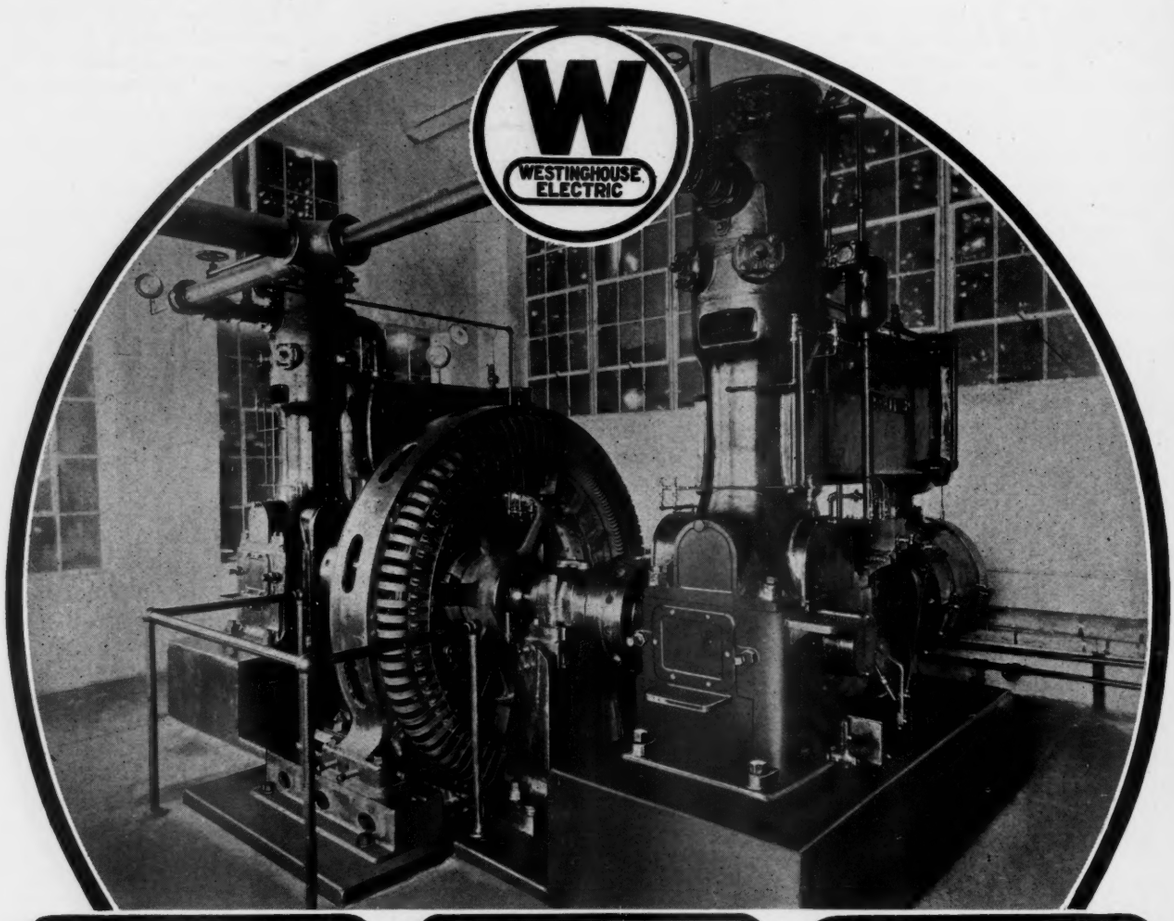
The United States export trade in all classes of leather for 1922 has shown a very marked increase over that for 1921. In some cases the advance has been especially noteworthy. Belting leather, for example, has registered an increase of nearly 50 per cent. and upholstery leather about 500 per cent., while other groups of leather exports show varying percentages between this minimum and this maximum.

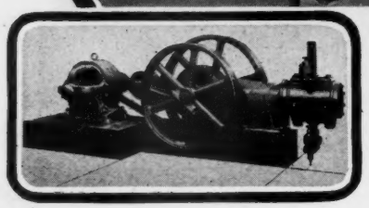
There are at present something like 41,500,000 persons gainfully employed in the United States. Nearly 60 per cent. of these, or 24,800,000 are servants, laborers, semi-skilled and skilled workers, while 14 per cent. are engaged in clerical or kindred activities. In other words, 30,500,000 of our citizenry, or 74 per cent. of all persons gainfully employed in this country, depend on their weekly pay envelope for a livelihood.

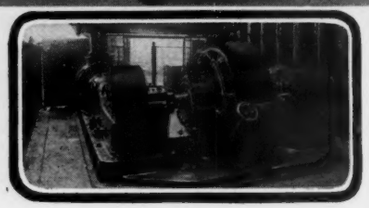
An executive circular has been issued by the Mexican government giving all petroleum companies operating in that country two months in which to solve the problem of preventing the loss of natural gas from oil wells. Those companies that fail to comply with the order will be taxed one centavo for each twenty meters of gas escaping. In granting future concessions it will be required that all new wells be satisfactorily equipped to collect the natural gas.

The Tenth National Foreign Trade Convention of the National Foreign Trade Council will be held in New Orleans, La., from April 25 to 27, inclusive. It is expected that, as in former years, leading foreign traders from every part of the United States, interested in every line of industry, as well as many business men from abroad will attend the convention.

Not less than 80 different types or different makes of the same type of electric furnaces have been used, tried, or suggested for the melting of copper, brass or bronze, aluminum, nickel alloys, etc. Descriptions of these various furnaces are contained in Bulletin No. 202, recently published by the Bureau of Mines, Washington, D. C.







IF YOU are in the market for compressor motors — make this test before you buy.

Go where motor driven compressors are used, and talk to the men who operate them. Inquire about the adaptability of motors to compressor drive. Ask about their dependability, construction, maintenance, efficiency, power consumption and service rendered under trying conditions.

Convince yourself from the unbiased information you will have gathered in the field.

We are confident that the reports on the performance of Westinghouse motors will have convinced you of their desirability for compressor drive.

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